

VOL. 198, NO. 1



JULY 2000

NATIONAL GEOGRAPHIC

WRATH OF THE GODS

CATASTROPHE
HAUNTS A
CRADLE OF
CIVILIZATION

AUSTRALIA 2 EARTHQUAKE IN TURKEY 32 HISTORY OF DISASTER 52
THE SAMOAN WAY 72 DAWN OF HUMANS 90 SLOT CANYONS 118

Washington, D.C., July 2000

Seen in light of the violent, earth-shattering events that have punctuated other regions throughout time, Australia can seem like a pretty sedate place. In the 50 million years since Australia separated from Antarctica and drifted north, few volcanoes have erupted, few glaciers have grown, and only low mountains have risen. Despite its geologic quiet Australia is a biological horn of plenty—one of the world's 17 megadiversity countries, according to Conservation International. This endowment, though, is threatened, largely due to Europeans who began arriving in the 18th century. Transforming an alien landscape to be like home, they upset the ecological equilibrium, and the consequences still reverberate today.

THE PHYSICAL ENVIRONMENT



Soils

- ☐ Sandy, shallow, or waterlogged
- ☐ Low in nutrients
- ☐ Naturally high in salt
- ☐ Generally fertile

Soil infertility is partly a result of the long absence of volcanism and glaciation—geologic processes that would have helped replenish the soil.

SUPPRESSING FIRE has gone out of fashion, as Australians realize the value of flames in maintaining ecological balance

FERAL CONTROL

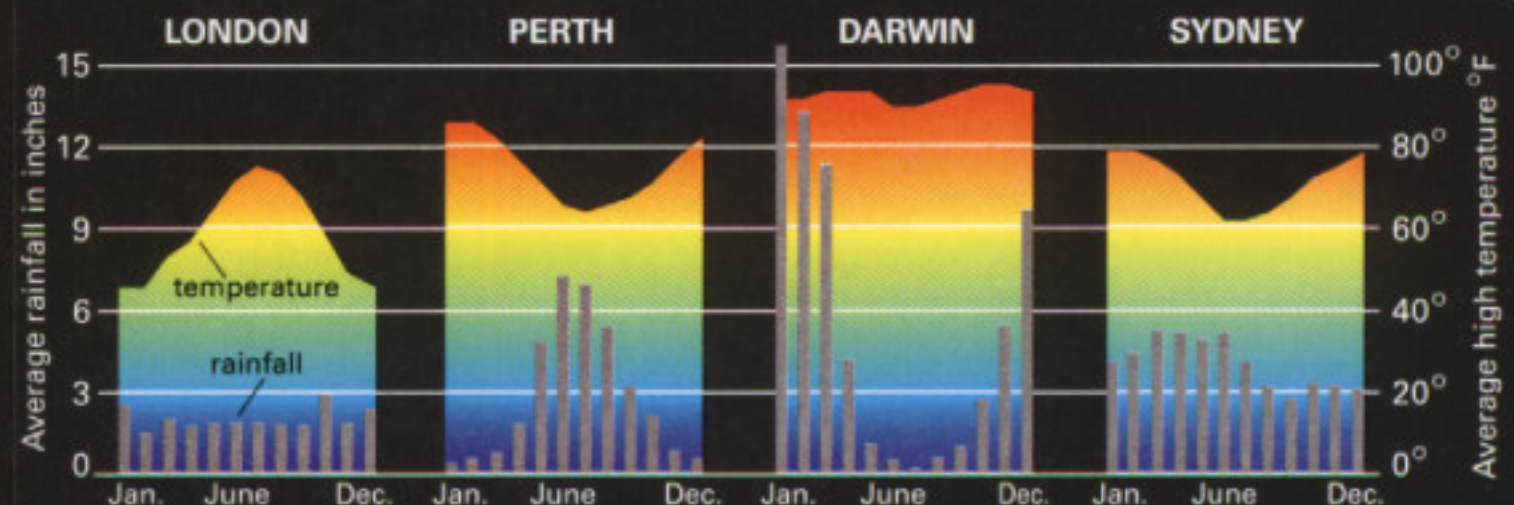
House cats and foxes, both introduced species, have decimated the wildlife of Western Australia and contributed to the extinction of ten native mammals. Wildlife managers have resorted to poisoning the predators.

RESTORING TREES
Some farmers are cultivating the Tasmanian blue gum (*Eucalyptus globulus*), one of the fastest growing native trees in Australia and an excellent source of wood fiber. Korean and Japanese paper companies have bankrolled these tree farms, which may relieve logging pressures elsewhere.

Prevailing winds from the southeast quickly release their moisture along the coast of Australia, leaving much of the continent arid or semiarid.

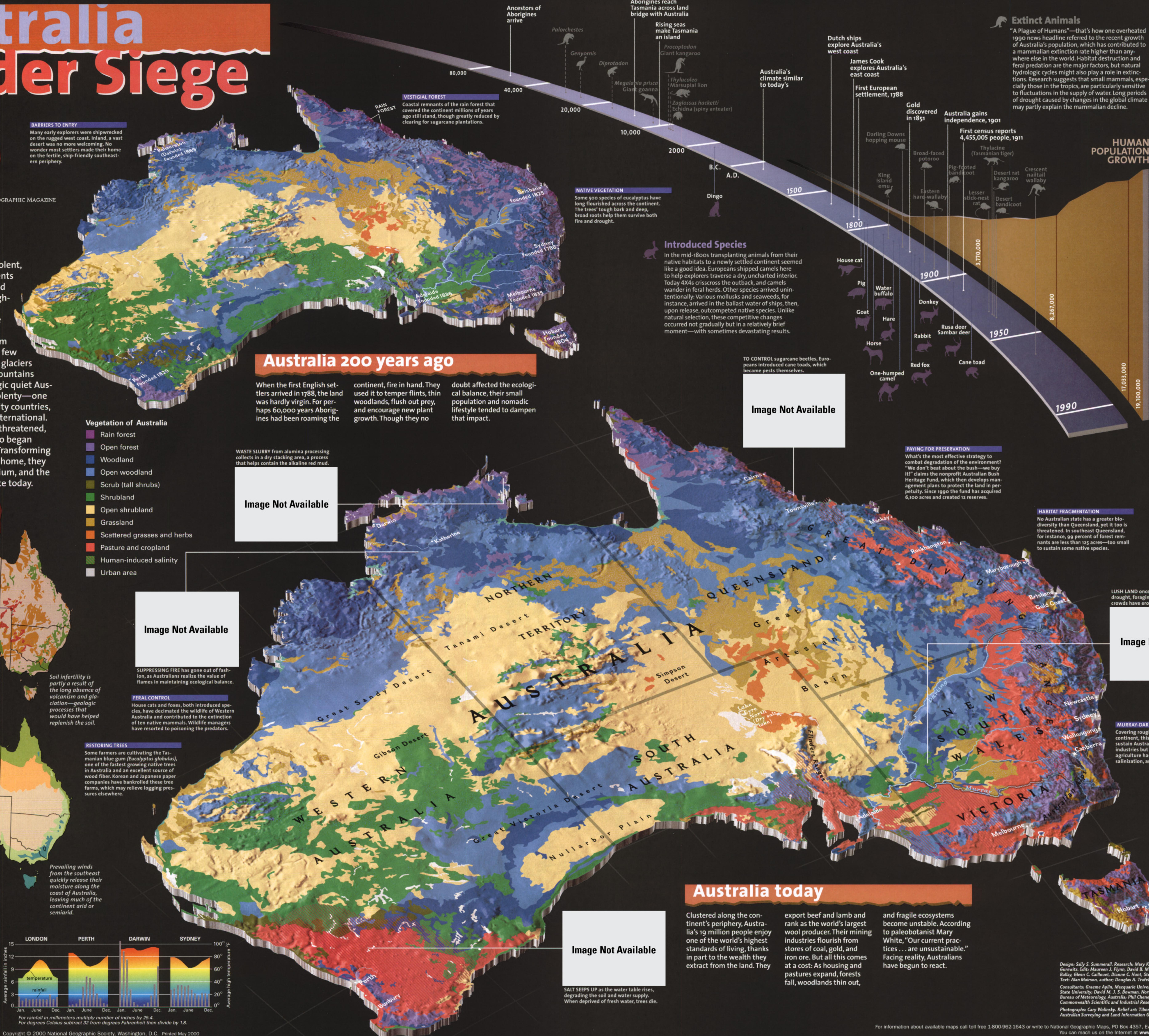
CLIMATE COMPARISONS

Early British settlers, accustomed to a moderate climate back home, found a land of extremes, especially along Australia's northern coast. There monsoons could drop more rain in two months than a Londoner would see in a year. And the heat must have seemed hellish.



For rainfall in millimeters multiply number of inches by 25.4.
For degrees Celsius subtract 32 from degrees Fahrenheit then divide by 1.8.

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FELLING THE FORESTS

Like a balding man's head, Australia lacks much cover in the middle but enjoys lush growth at the fringes—yet even that's disappearing. More than 35 percent of Australia's woodlands have been cleared or severely altered, and three-quarters of the rain forest has been destroyed. All this felling hastens soil erosion and has let the water table rise, resulting in an alarming spike in soil salinity. Queensland has one new region of bright green growth, but it's hardly a blessing. An introduced tree—the prickly acacia—is turning native pastures into shrubland.

Vegetation changes

- Grassland reduction
- Shrubland reduction
- Woodland or forest loss
- Gain in tree cover

A FERAL INFESTATION

Over the years Europeans have introduced a host of non-native animals that have become a feral menace. Joining the destructive dingo, brought in 3,500 years ago by Asian seafarers, are the horse, camel, goat, pig, donkey, water buffalo, and house cat—all of which pose ecological problems. Rabbits, another alien invader, dig burrows and hasten desertification. Foxes, first introduced by sportsmen in the 1860s, are one of Australia's most aggressive predators, killing rabbits but also countless marsupials.

Introduced game animals

- Present extent of most fox and rabbit populations
- Fox invasion
- Rabbit invasion
- Area where animals were introduced

FIRE HAZARDS

For some Aborigines practiced "fire-stick farming," applying the torch to the land in a carefully controlled way to clear and rejuvenate land for hunting and gathering. Such regular "cool burns" also reduced the amount of fuel available for hotter, more damaging fires that ignite naturally. Europeans, though, deemed fire a threat to life and property and for many years suppressed all fires. As a result, bush-fires have intensified, partly because stray sparks now find an oversupply of fuel.

Potential for disastrous bushfires

- Extreme
- High
- Moderate
- Low
- Area of periodic drought, 1990s

OVERGRAZING

As sheep and cattle graze their way across Australia's pastures, they strip ground cover, hastening soil erosion. Water troughs built for livestock also refresh and sustain wandering feral herds. And as pasture expands, natural habitats for native species disappear. The range contraction of the Gouldian finch, for instance, may be caused by expansion of pastureland. One big fear among environmentalists is that relentless grazing will transform marginal terrain—the shrublands and semiarid grasslands—into desert.





Grazing land

- Cattle
- Sheep
- Sown pasture and cropland

MINING MATTERS

On any continent, extracting minerals and fossil fuels from the ground is a change in the natural order—often a harmful one. Digging massive open-pit mines and building the infrastructure to exploit them inevitably affects animal and plant habitats. Mine waste can pollute surface water and groundwater. The Australian government is promoting environmentally sensitive mining practices, including the rehabilitation of open-pit coal mines into native wildlife reserves.

Mining

-  Gold, iron ore, copper, or bauxite
-  Diamonds, opals, or sapphires
-  Fossil fuels
-  Uranium

Australia today

Clustered along the continent's periphery, Australia's 19 million people enjoy one of the world's highest standards of living, thanks in part to the wealth they extract from the land. They

export beef and lamb and rank as the world's largest wool producer. Their mining industries flourish from stores of coal, gold, and iron ore. But all this comes at a cost: As housing and pastures expand, forests fall, woodlands thin out,

and fragile ecosystems become unstable. According to paleobotanist Mary White, "Our current practices . . . are unsustainable." Facing reality, Australians have begun to react.

Image Not Available

SALT SEEPS UP as the water table rises, degrading the soil and water supply. When deprived of fresh water, trees die

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Washington, D.C., July 2000

Map Legend

- Limited-access highway
- Point of interest
- Rail
- Water hole or well
- Oil pipeline
- Aboriginal land
- Passenger railroad
- Desert
- Airport
- Dry salt lake
- International airport
- Park, reserve, sanctuary
- Homestead
- Swamp
- Oil field

Azimuthal Equal-Area Projection
SCALE 1:6,766,055 or 1 INCH = 107 MILES

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Today, the California Air Resources Board has just issued an even stricter emissions standard for 2004: Super Ultra-Low Emission Vehicle (SULEV). Naturally, we've decided not to wait. The Accord SULEV will be the first gasoline-powered vehicle to meet this standard, and is now available in California. Looks like it's time to find a new message for the bumper of your Honda.

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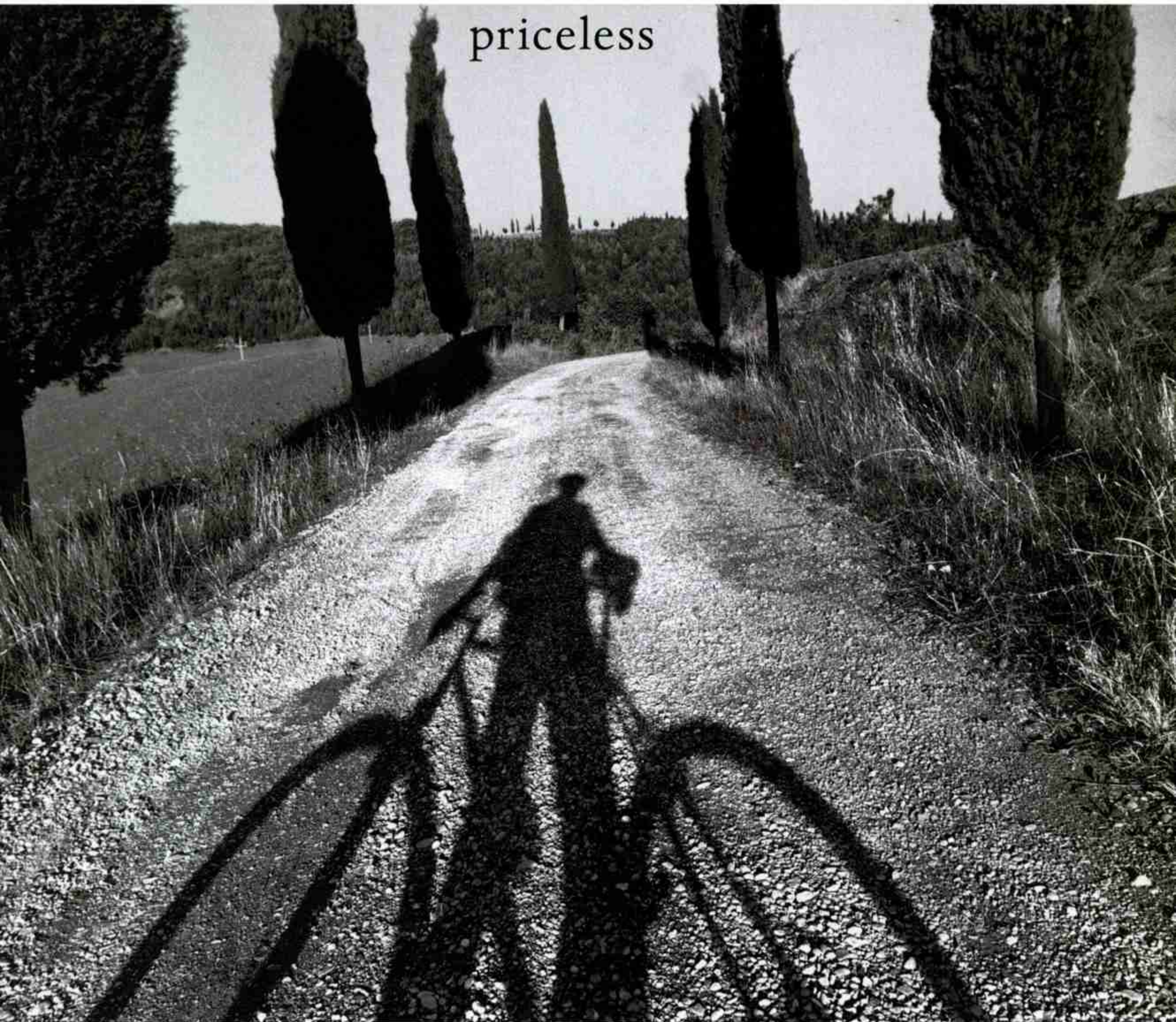
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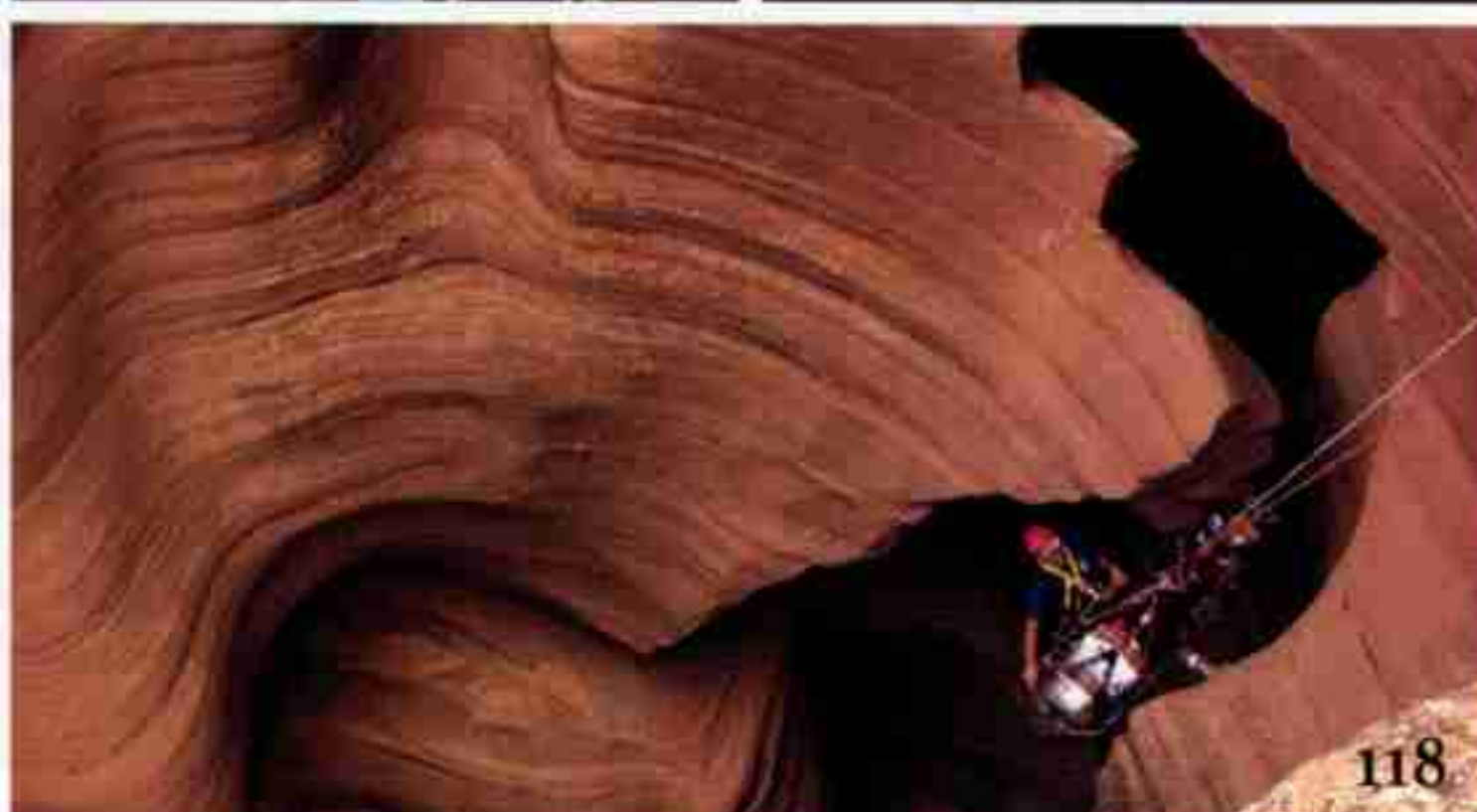
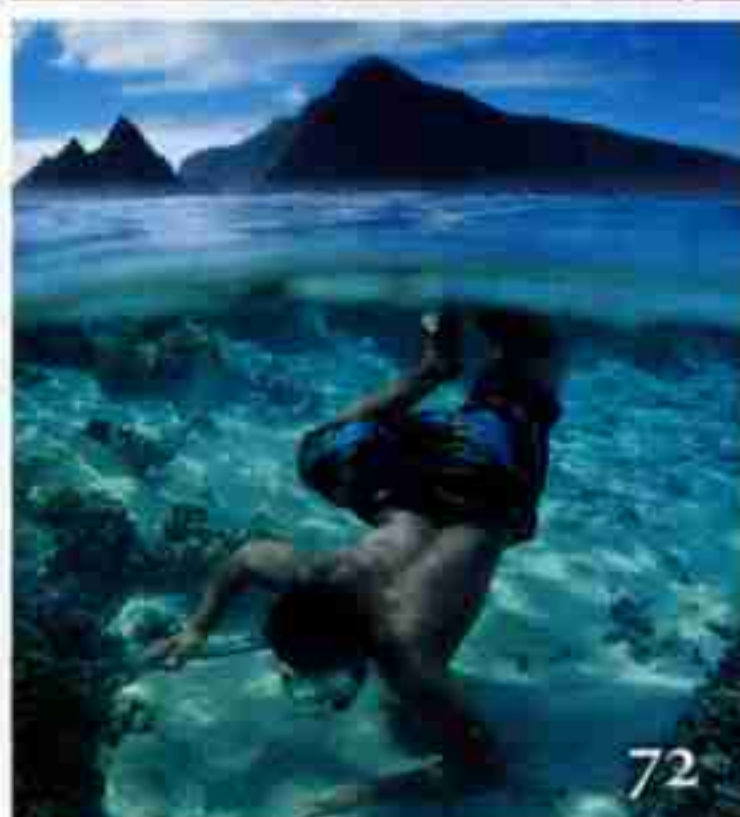
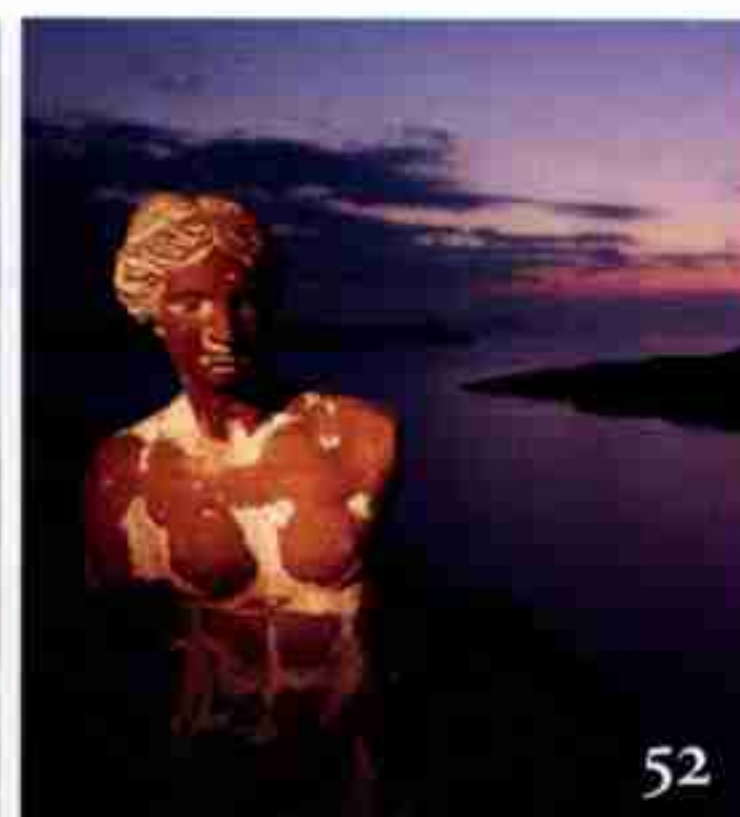
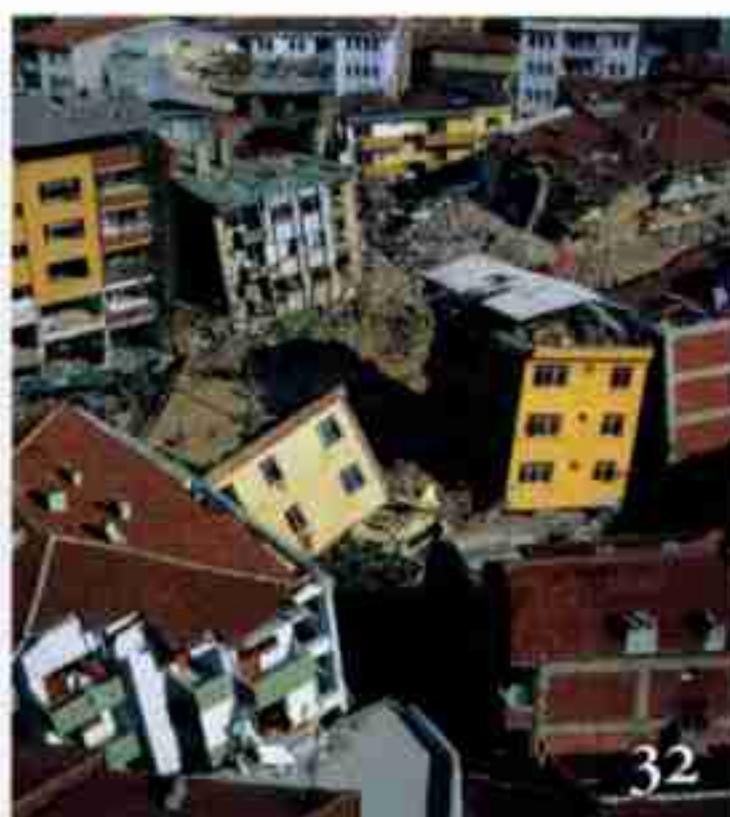
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NATIONAL GEOGRAPHIC

JULY 2000



- 2 **Australia—A Harsh Awakening** *The first European settlers wanted this island continent's bizarre landscape to look more like home. Now barren fields of salt and dwindling marsupial populations have Australians wrangling over how to repair damage done to their unique environment.*

BY MICHAEL PARFIT PHOTOGRAPHS BY CARY WOLINSKY

■ Double Map Supplement: Australia

- 32 **Wrath of the Gods ■ Earthquake in Turkey**
■ A History Forged by Disaster *Last year two massive quakes tore through Turkey, killing tens of thousands and leaving many more homeless. The relentless tectonic forces that have rocked the region for millennia nurtured myths of Poseidon and tales of Troy and may explain why Noah had to build an ark.*

BY RICK GORE PHOTOGRAPHS BY REZA

- 72 **The Samoan Way** *A tropical paradise in a remote corner of the Pacific Ocean, American Samoa is home to a new U.S. national park that aims to protect the islands' rain forests, coral reefs, and traditional Samoan culture.*

BY DOUGLAS H. CHADWICK PHOTOGRAPHS BY RANDY OLSON

- 90 **People Like Us** *When did humans begin to create art, practice rituals, develop sophisticated hunting strategies? Anthropologists have long associated the advent of the "modern" mind with the Cro-Magnons, who arrived in Europe some 40,000 years ago, but recent evidence suggests that the transition may have happened thousands of years earlier.*

BY RICK GORE PHOTOGRAPHS BY KENNETH GARRETT
 ART BY GREGORY MANCHESSE

- 118 **Playing the Slots** *A canyoneer's heaven can quickly turn into a watery hell as flash floods continue to carve the sandstone slot canyons along the Utah-Arizona border.*

BY SCOTT THYBONY PHOTOGRAPHS BY BILL HATCHER

Departments

On Assignment
 Geographica
 Forum
 On Screen
 Earth Almanac
 From the Editor

Flashback
 Behind the Scenes
 CartoGraphic
 OnLine

The Cover

Felled by an earthquake, a stone head on Nemrud Dagh in eastern Turkey is part of a 2,000-year-old shrine built by Antiochus I to glorify himself for eternity. Photograph by Reza

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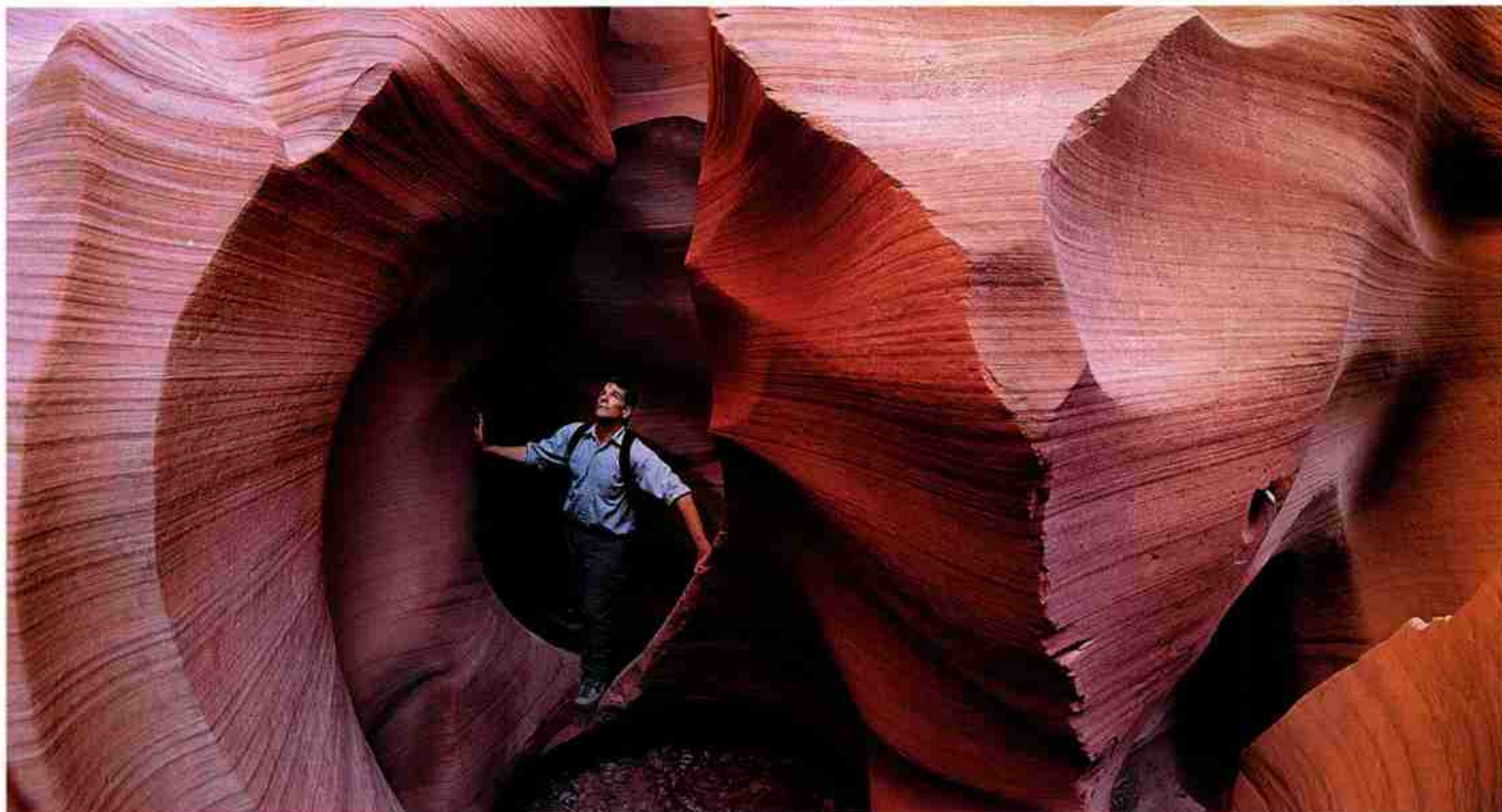
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On Assignment



BILL HATCHER

■ SLOT CANYONS

Seductive Slots

“The amazing beauty of water-carved sandstone draws people into the slot canyons,” says Scott Thybony, here pictured in Antelope Canyon, near Page, Arizona. “But it’s easy to forget that these canyons are still being formed and flash floods sweep through often.” During Scott’s first expedition in a slot canyon he raced a gathering storm, uncertain when he would find an escape route. Finally reaching the rim, he watched water cascading into the twisting narrows—where he’d been only an hour before.

■ WRATH OF THE GODS

A Good Head On Its Shoulders

“I’ve had a camera around my neck for 34 years,” says Reza. “I couldn’t imagine having my picture taken without it.” Reza spent four days with his camera on the summit of Turkey’s Nemrud Dagh photographing the ruins of a monument built 2,000 years ago by Antiochus I, including colossal statues and relief panels of ancient deities, heroes, and ancestors. Many are now headless, partly as a result of earthquakes rocking the region over the centuries.

Today tourists visit the ruins on 7,000-foot-high Nemrud Dagh, especially at sunrise and sunset, taking the last 1,500 feet by foot or mule. Reza and his assistant, Aydin Kudu, lugged his equipment up each day before dawn in chilling temperatures and again before dusk to capture the magical light of low sun on old stone. “It is the most breathtaking viewpoint in Turkey,” Reza says.



AYDIN KUDU

GOOD HANDS.SM

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NATIONAL GEOGRAPHIC

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New "Pictures" of a Giant Bird

Aptly named, Madagascar's *Aepyornis maximus*, or largest tall bird, stood nearly ten feet and weighed half a ton. GEOGRAPHIC writer-photographer Luis Marden acquired two foot-long fossilized eggs of the bird, extinct since at least the 16th century, for a 1967 article; x-rays at the time showed an embryo inside one. Now CT scans by Timothy Rowe (above) of the University of Texas reveal that the second egg also held an embryo (left). "We think it died a third of the way through development, and the bones sank into a pile," Rowe says. "We can see leg, foot, and pelvis bones, and a little of the beak." Comparison with other large birds may yield insight into how *A. maximus* developed.



ART BY WALTER A. WEBER (TOP); JOSEPH JAWORSKI, UNIVERSITY OF TEXAS AT AUSTIN (INSET); COMPUTER RECONSTRUCTION OF CT SCAN BY RICHARD KETCHAM AND MATTHEW COLBERT, UNIVERSITY OF TEXAS AT AUSTIN

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DAVID W. HARP (ABOVE LEFT); JAMES A. PARCELL, WASHINGTON POST

Reminder of a Passing Era Afloat Again on the Chesapeake Bay

"A freak thing," Capt. Wade Murphy calls the sudden squall that sent his skipjack, *Rebecca T. Ruark* (above), to the bottom of Maryland's Choptank River last November on the second day of oyster season. A crane raised her three days later (above right) and towed her to Tilghman for repairs.

Now she is giving educational tours and waiting for oyster season. *Rebecca*, built in 1886, is one of 13 skipjacks—single-masted working boats, usually with a V-shaped keel—still oystering on the Chesapeake. "I've been on the water for 43 years and never had something like this happen," says Murphy.



NAGUIB KANAWATI

■ NGS RESEARCH GRANT (After)life Sentences

Ancient chronicles say that Teti, founder of Egypt's 6th dynasty more than 4,300 years ago, was assassinated. His successor lasted less than two years before Teti's son Pepy I seized power and punished the killers, including Teti's chief administrator and several bodyguards. Recent excavations of Teti's cemetery at Saqqara suggest that the traitors' punishment extended to eternity: Their names and likenesses were chiseled off the walls and doors of their tombs. "This deprived the tomb owners of perpetual life in the hereafter," says Naguib Kanawati, the dig's leader.

TEXT BY BORIS WEINTRAUB

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Forum

Photographer Joel Sartore won the admiration of readers of our March issue for his striking photography in Bolivia's Madidi National Park. "I had no idea what misery a photographer can go through just to get a picture," said one. "I admire his guts and his passion for photography—he is my personal hero," wrote another. "Congratulations for this vivid glimpse of the pain behind the story," said a third.

Madidi National Park

Attracting tourists to Madidi may help conserve its wildlife but at the expense of killing off the local culture. The very fact that people of that region follow a way of life that they have for generations, eat different food, and speak little English is precisely what would make it an interesting place to visit.

ERIC HAUSER
Silver Spring, Maryland

Is there no responsibility on the part of the visitor toward this threatened landscape other than to get on and off the plane, click the shutter at the appropriate time, and enjoy the amenities and conveniences of home? Author Steve Kemper points out that in order to be a success, ecotourism must first pander to the visitor to the extent that it undermines indigenous cultures. Addressing the gross inequalities that created the pressing need for a solution in the first place would be much more beneficial than opening yet another frontier to the trammeling hordes of well-heeled tourists.

NICK CRADOCK-HENRY
Waterloo, Ontario

Kemper's article concludes that the best hope for Madidi's future is for the park's residents to learn to manage tourism. For this to happen, the park needs tourists. Joel Sartore's attention-seeking journal goes a long way to make sure that Madidi doesn't find its way onto any tourist "places to visit" list.

THADAIGH BAGGALLAY
Olympia, Washington

The Tacana guides pictured taking a bath on pages 22-3 had better get their own act straightened out before the tourists come. If 10,000 gringos all start soaping up in the river, it's just a matter of a few years before the environment will feel the effects.

WILLIAM LOUKIDES
Toronto, Ontario

Bugging Out

I loved the article on Madidi National Park and was almost ready to pack my bags until I read the

pages from Joel Sartore's journal. Somewhere amid the excerpts on burrowing insects, toxic leaves, and flesh-eating parasites, my crawling skin convinced me to leave that adventure up to tougher travelers.

SARAH BERRY
Indianola, Washington

I'll never, ever complain again about the hazards of living at a remote salmon hatchery in southeastern Alaska. I'll take brown bears for neighbors, fierce winter storms with hundred-knot wind gusts, and intermittently operating radio-telephone hookups any day over the conditions local people and visitors alike must endure daily in Madidi.

LITIA GARRISON
Port Armstrong, Alaska

Whatever you paid Mr. Sartore, it wasn't enough.

JAY HARMON
Baton Rouge, Louisiana

Arctic Submarine

In the midst of a presidential election year there is likely to be no shortage of junk science bandied about regarding global warming and the combustion of fossil fuels. I appreciate the fact that NATIONAL GEOGRAPHIC has stated the truth—that scientists don't have a clear understanding of the causes or implications of global warming.

DAVID CUSHMAN
Lake Zurich, Illinois

Ancient Greece III

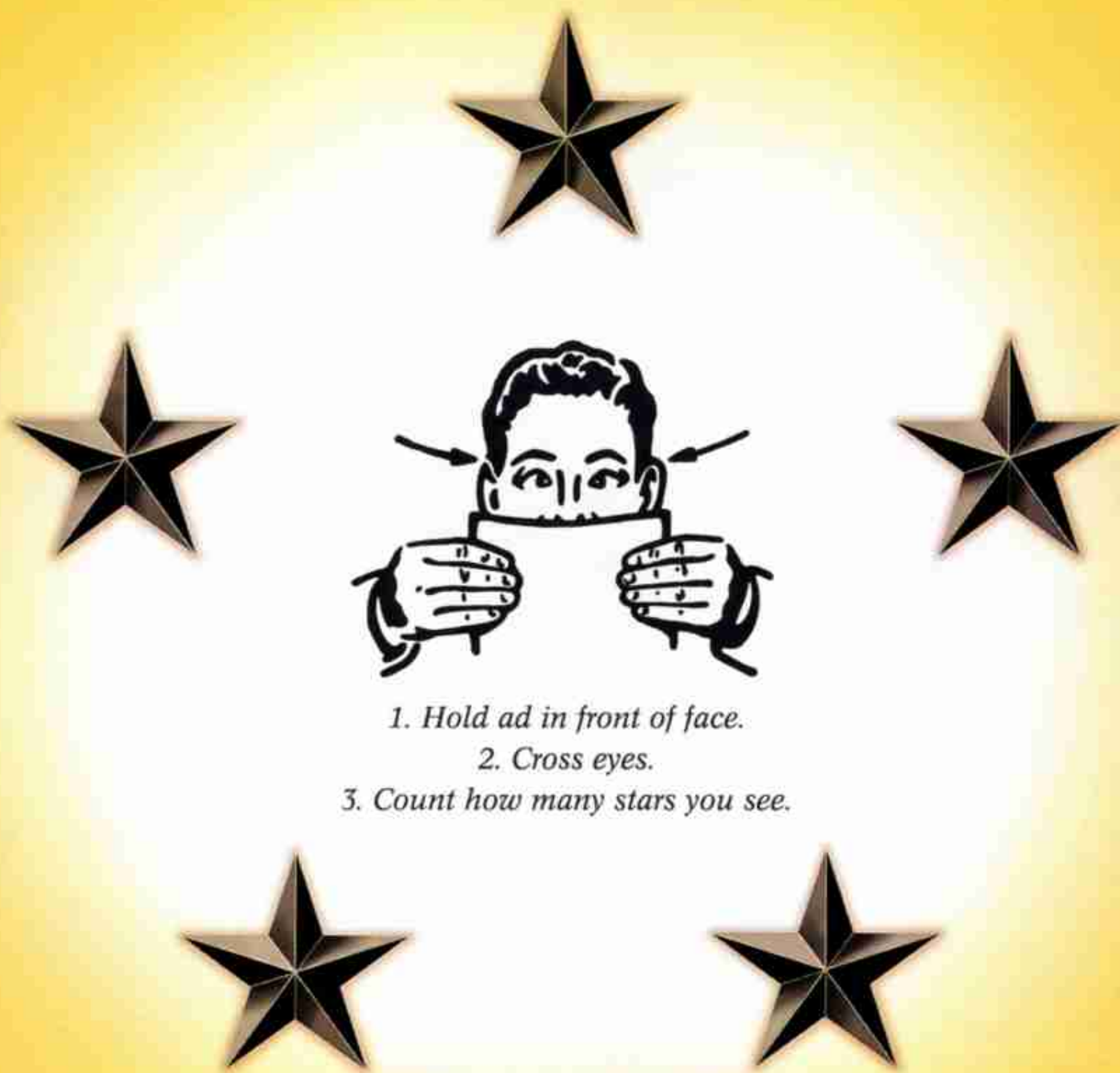
When I read about Plutarch's biography of Alexander, which included a description of the rare eye condition Brown's syndrome, I knew that same description applied to my son. For years I had described to doctors the "melting look," the tilting of the head in order to see straight. Armed with your article, I insisted on his being checked, and today my son was diagnosed with Brown's syndrome. Without your information I might never have found out.

KATHY BRISENDINE
Laconia, New Hampshire

I disagree with the author's view that Alexander lacked administrative skills in managing his conquests. He tolerated many local customs, appointed local administrators to help govern captured territories, built cities from the ground up, and even adopted Persian dress and customs to consolidate his empire. If his efforts seem crude or shortsighted to us, they were some of the best, most creative of his day. In an era where it was acceptable to exterminate all occupants of conquered territories, Alexander's attempts at administration seem laudable.

DONALD F. LAMAR
Fort Wayne, Indiana

Caroline Alexander's last name is a manifestation of the cult of Alexander. It was especially strong in France, where the *Romans d'Alexandre* established the verse form typical of French poetry. It influenced Napoleon, whose futile Russian expedition was a frigid version of Alexander's push to the east.



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The difference was that Napoleon had a grand design for organizing his empire; Alexander did not.

RONALD HILTON, *Professor Emeritus
Stanford University
Stanford, California*

Alexander had a pragmatic strategy in regard to military grooming. He was the first, legend says, to institute shaving in his army, so that the enemy in close combat would not have anything to grasp.

SPYROS CHIONOS
Windsor, Ontario

Your article cries out for comparison with the December 1996 article on Genghis Khan. Both men, with similar-size armies, conquered much of their known world, leaving behind short-lived empires that rapidly broke up into independent kingdoms. Yet Alexander is portrayed as the spearhead of cultural advance who happened to massacre some folks along the way, while Genghis is portrayed primarily as a killer who happened to leave some culture in his wake. One gets the impression that leaders of European hordes are held to a different standard than leaders of non-European ones.

GEORGE KINGSTON
East Longmeadow, Massachusetts

Hard Rock Legacy

The article inaccurately attributes instances of environmental degradation to the 1872 mining law, which is a land-use statute, not an environmental statute. Your readers should know that America's mining industry is subject to over three dozen separate federal and state environmental laws and regulations. Today's mines spend millions of dollars each year to enhance air and water quality, reclaim mined land, and provide habitat for wildlife.

RICHARD L. LAWSON, *President
National Mining Association
Washington, D.C.*

Your article on hardrock mining in the West ends with a vision of "dead lakes shining in the desert sun." The Sleeper Mine north of Winnemucca, Nevada, provides a different, more hopeful picture. Since the mine shut down two years ago, it has become an outstanding habitat for waterfowl and deer. This resulted from the joint efforts of the mining company, state regulators, and local wildlife groups. This type of cooperative, proactive approach is not atypical and is much more constructive than hand-wringing over past practices.

DOUG HOCK
*Newmont Mining Corporation
Denver, Colorado*

I've appraised all kinds of mines, and I'm grateful to the mining industry for providing us with all the things that we use. But I have no sympathy for government-subsidized gold miners who want their free ride to go on forever. If they can't live without it, they can always go broke. Other types of businesses do that every year.

ROBERT H. PASCHALL
Bishop, California

In the country that has the highest resource consumption in the world, few people understand the importance of maintaining strong primary production industries. We were glad to be able to type this letter on a computer, whose chips and wires are born in mines and oil wells. By encouraging environmentally responsible production of our natural resources, the United States can continue to be a positive role model for our world.

HEIDI ZIMMERMAN AND GARY BROWN
Kansas City, Missouri

Stone Cold Ascent

In spite of excellent photographs, the tone of the article in its celebration of unwashed menfolk glorying in their collective testosterone while ascending heretofore unconquered (in winter, at least) peaks struck me as more suitable for a badly done beer commercial than the pages of your magazine.

BRIAN GREEN
Seattle, Washington

While reading this fabulous article I had to put the magazine down several times to wipe the sweat from my hands. The mountain may be mythic, but Ulrich, Fasel, Crouch, and Siegrist are the stone-cold real deal.

TOM MINER
Ontario, Oregon

Beijing

The Beijing street scene on pages 118-19 prompted me to compare it with photos I took during a two-week visit to Beijing in 1978. The most striking difference is the variety of multicolored Western-style clothing. In 1978 the clothing colors were all the stark blue or black of the Cultural Revolution.

JOSEPH J. NEFF
Indianapolis, Indiana

The 1989 occurrence at Tiananmen Square was an important and unfortunate incident that we should all draw lessons from. But is it really prudent to suggest that this one event is more significant than the 400 years of history the square has weathered, not least of all the presence of foreign troops in the middle of the 19th century?

YUE WU
Cambridge, Massachusetts

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NATIONAL GEOGRAPHIC

OnScreen



PAUL NICKLEN

■ EXPLORER, JULY 9

Icy Kingdom of the Walrus

With the horizon clear of polar bears and Inuit hunters, walrus bulls spar on a slab of ice in Canada's Hudson Bay. They have hauled themselves up after devouring thousands of clams on the seafloor, one of the many remarkable scenes of walrus behavior revealed this July in *Toothed Titans*. Producer Adam Ravetch spent years shadowing a herd of walrus. "I wanted to show the essence of this legendary creature," he says. His diligence paid off. The show presents such rarely filmed sights as dozens of walrus swimming underwater, a mother nursing a newborn calf, and a surprise polar bear attack.

■ PROGRAM GUIDE

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Photographed by Jack Jeffrey

WILDLIFE AS CANON SEES IT

A nightingale reed-warbler sings vigorously to defend its territory. Only the male sings, often remaining vigilant into the night with minutes of continuous melodic song. His mate stays nearby, ready to assist in defense. The reed-warbler's spectacular song belies its shy nature; known as "bird of the reeds" on Saipan, it usually remains well concealed in dense habitat. Short, round wings and a long tail enable the songbird to maneuver thickets and reedbeds, where it uses its long bill to snatch a variety of prey, from insects to geckos. The nightingale reed-warbler is

vulnerable to habitat loss and introduced predators.

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Nightingale Reed-warbler
(*Acrocephalus luscini*)

Size: Length, 18 cm

Weight: Approx. 35 g

Habitat: Reed marshes, forest edges and thickets on the Mariana Islands of Saipan and Alamagan

Surviving number: Estimated at 6,200



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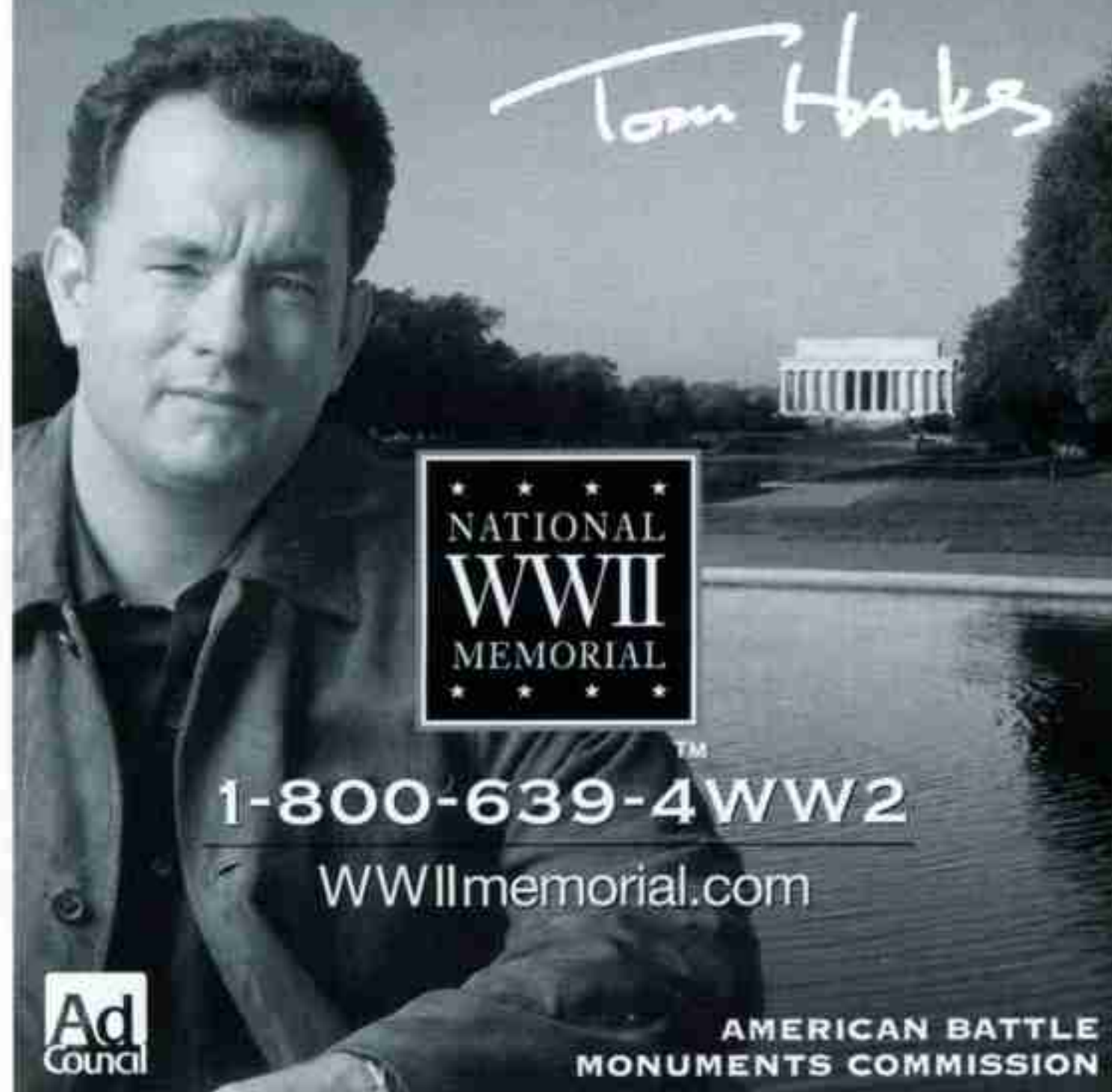


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Earth Almanac

India's Black Market Is Alive—Wildlife Is Not

A roomful of contraband represents a rude awakening for India's wildlife officials, who say they did not realize the severity of the poaching problem. Six months ago four raids netted:

- 12 tiger skins
- 132 claws from eight tigers
- 385 pounds of animal bones
- 124 leopard skins
- 18,080 claws of more than a thousand leopards.

The evidence is sobering, since India has about 60 percent of the world's remaining 4,500 to 7,000 tigers. A news report suggested that one seized skin might be that of the tigress called Sita, featured in the December 1997 *GEOGRAPHIC*. However, Belinda Wright, executive director of the Wildlife Protection Society of India, examined the pelt and says that its markings "are definitely not Sita's." Authorities believe that the tiger, 16 years old when last seen in October 1998, has probably died of natural causes.



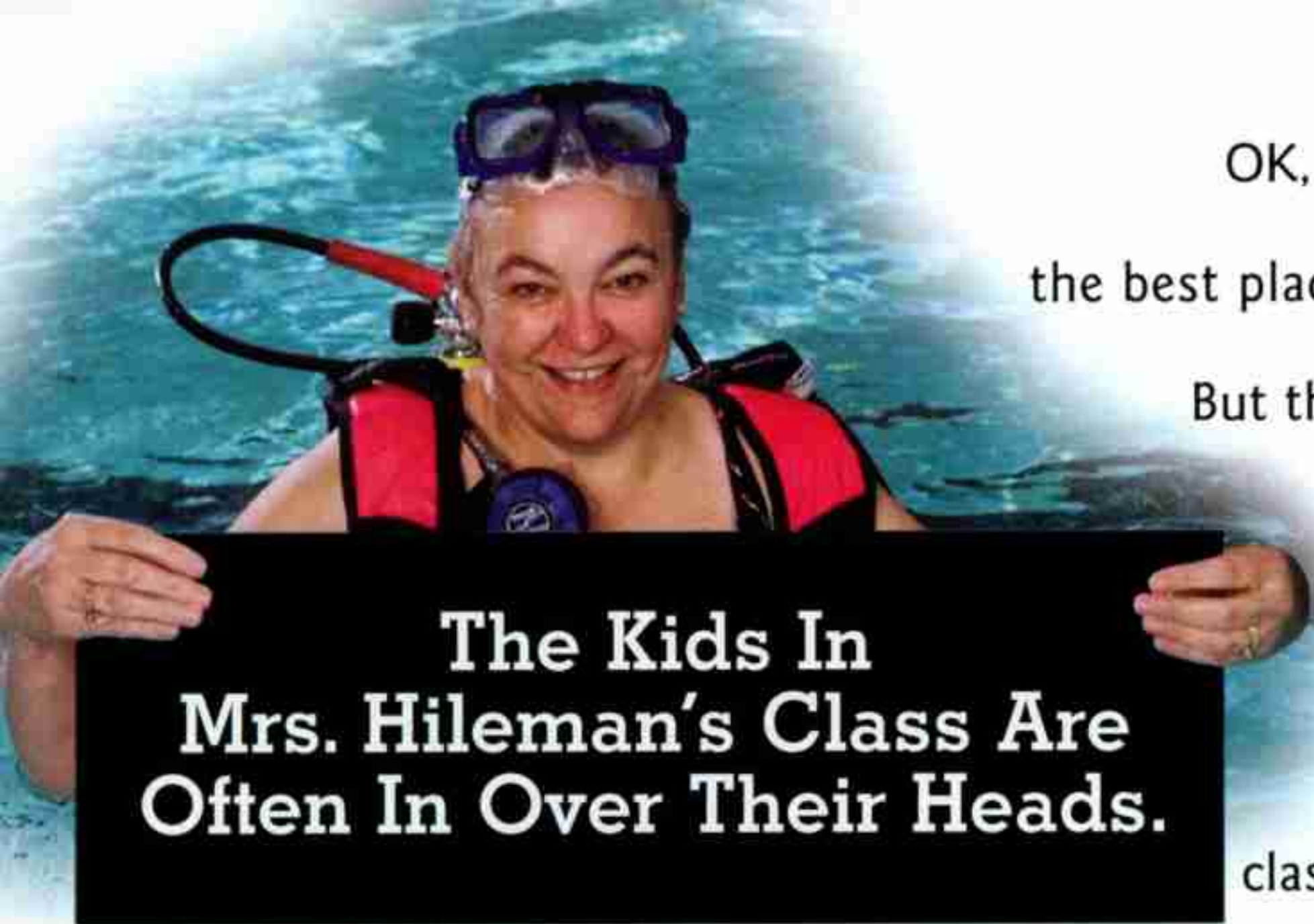
PALLAVA BAGLA



PETER ESSICK

Preserving Lewis and Clark's Heritage

Meriwether Lewis and William Clark saw a lot of country on their 8,000-mile trek from the Missouri to the Pacific from 1804 to 1806. With that bicentennial nearing, the Sierra Club seeks to protect 34 sites near the route. One of these, the Buffalo Gap National Grassland, spreads 591,000 acres over South Dakota. "We want more designated wilderness, more buffalo, and a halt to railroad expansion," says Sam Clauson, head of the South Dakota chapter.



The Kids In Mrs. Hileman's Class Are Often In Over Their Heads.

OK, so the mountains of Wyoming may not be the best place to teach children about oceanography.

But then fifth grade teacher Linda Hileman

would never let the fact she lives 1,500

miles from the ocean ruin a good lesson

plan. In fact, she not only teaches her

class about our undersea world, she takes

them there thanks to a little imagination and lots of borrowed scuba equipment. With the aid of several certified safety divers, Mrs. Hileman familiarizes her students with the equipment and basic techniques of scuba diving. Then she takes them diving at a neighborhood pool set up with underwater activity stations. There the students attempt tasks such as riding a tricycle, communicating via hand signals and other work-related tasks that give them an appreciation for the difficulties oceanographers face living and working underwater. For helping her land-locked students immerse themselves in the science of oceanography, State Farm is proud to present Linda Hileman with our Good Neighbor Award® and to donate \$5,000 in her name to the Saratoga Elementary School Library, in Saratoga, Wyoming.

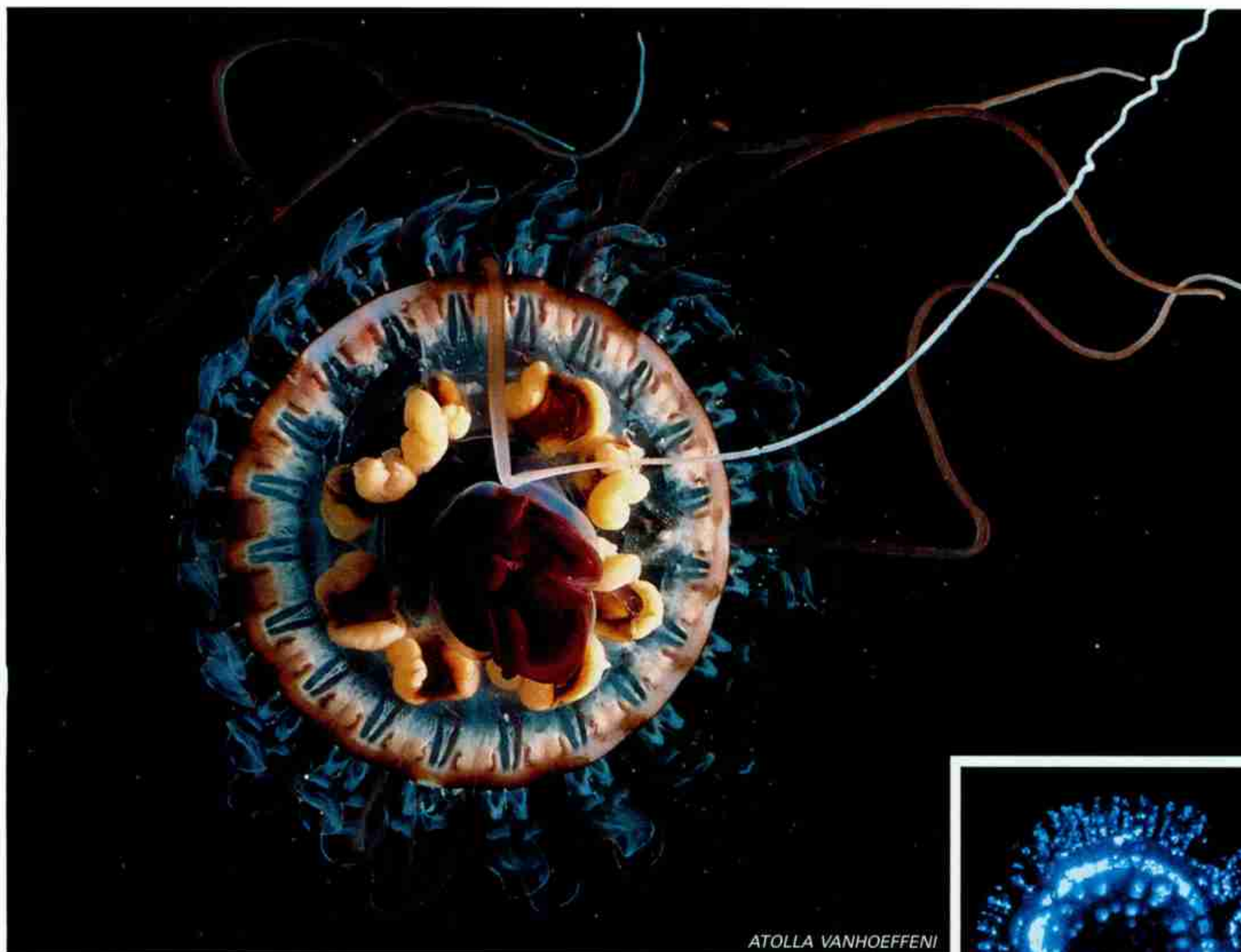


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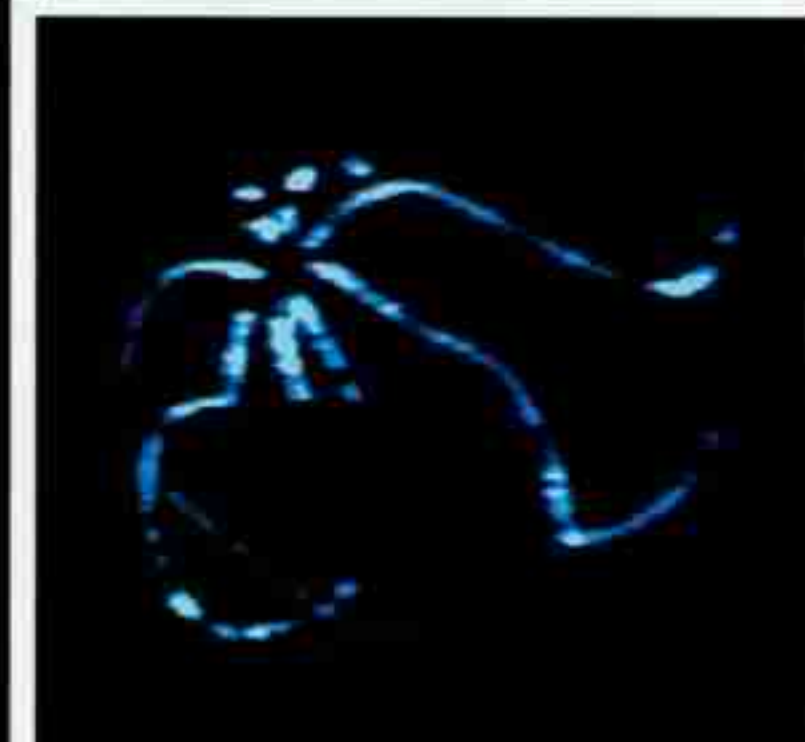
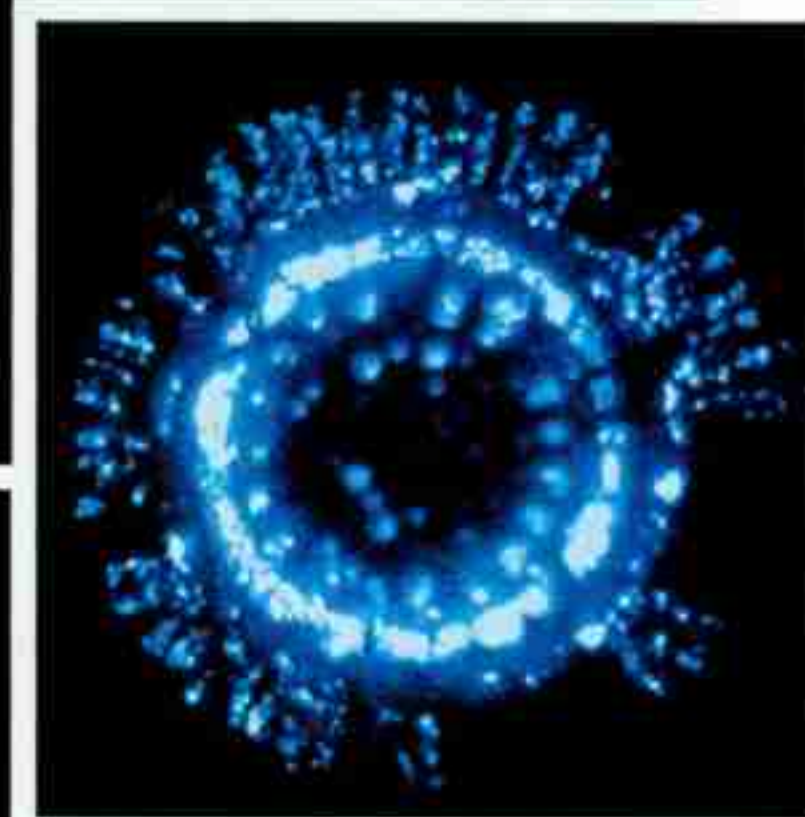
Glowing Jellyfish Have a Lot to Say

"Bioluminescence may be the most common communication on the planet," says Edith Widder of Harbor Branch Oceanographic Institution in Florida. In her view the vast majority of marine organisms—and 99 percent of the biosphere is marine—are bioluminescent. Their signals warn predators, seek help, or get attention, as in these jellyfish, shown with lights both off and on.

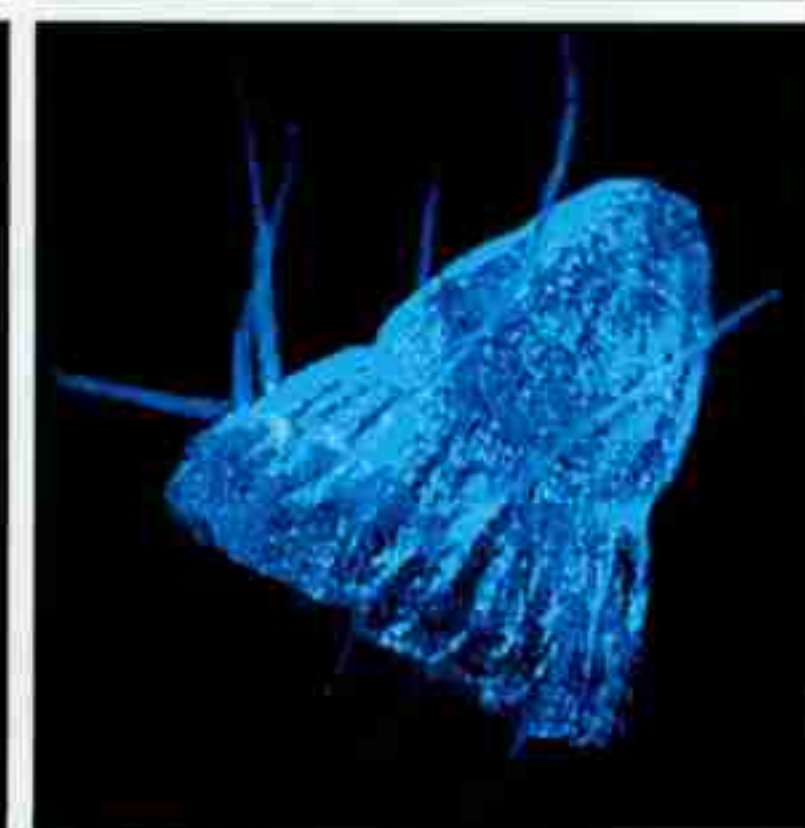
Atolla vanhoeffeni, a carousel when unlit (above), lights up like a movie marquee when threatened (far right, top). *Periphylla periphylla* displays an orange bell, but when in danger (far right, bottom) it emits a glowing substance that sticks to its foe—where it may attract a predator to attack the attacker. *Bathocyroe fosteri* leaves but a ghostly glow (far right, middle), perhaps just to say, "I am here."



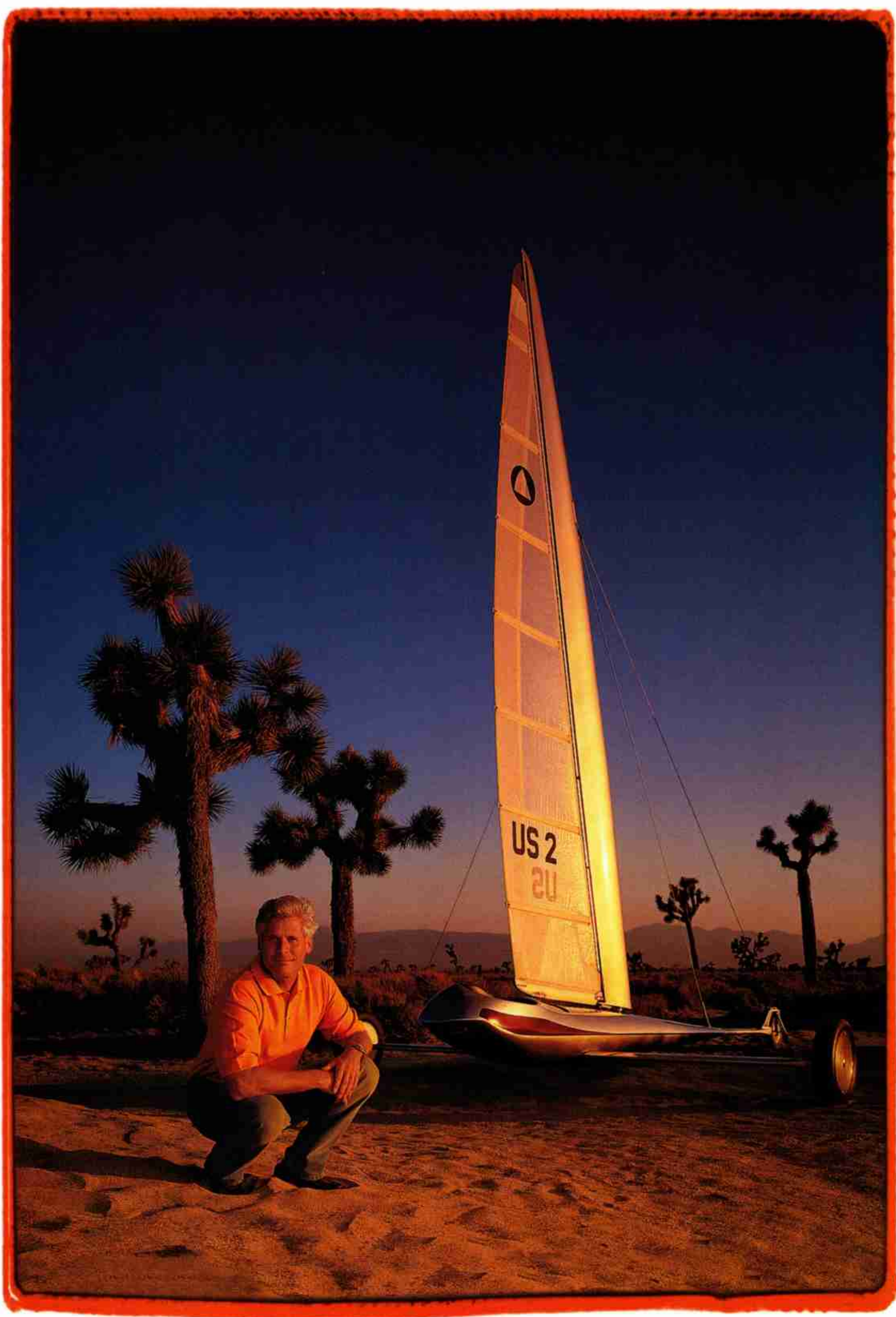
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PERIPHYLLA PERIPHYLLA



ALL BY EDITH WIDDER



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NEW WAYS

TO GET AROUND

If it's new and it's got wheels, chances are it came from Southern California. People here aren't just content to walk; they'd rather pedal, skate or scoot.

Maybe it's great weather that inspires Southern Californians to design so many ways to get out and about. Or maybe it's the

The Prius hybrid vehicle



Toyota's design center, CA

wide-open spaces. Whatever it is, innovation is no stranger to the roads and pathways of this beautiful corner of the world.

It's probably no coincidence, then, that the design for the world's first mass-produced hybrid vehicle was developed in Southern California. In Newport Beach, to be precise, at Toyota's futuristic North American design center, known as Caltex.

Here, a team of designers created the distinctive look that is turning heads in the U.S. and overseas for Toyota's breakthrough alternative fuel vehicle, the Prius.

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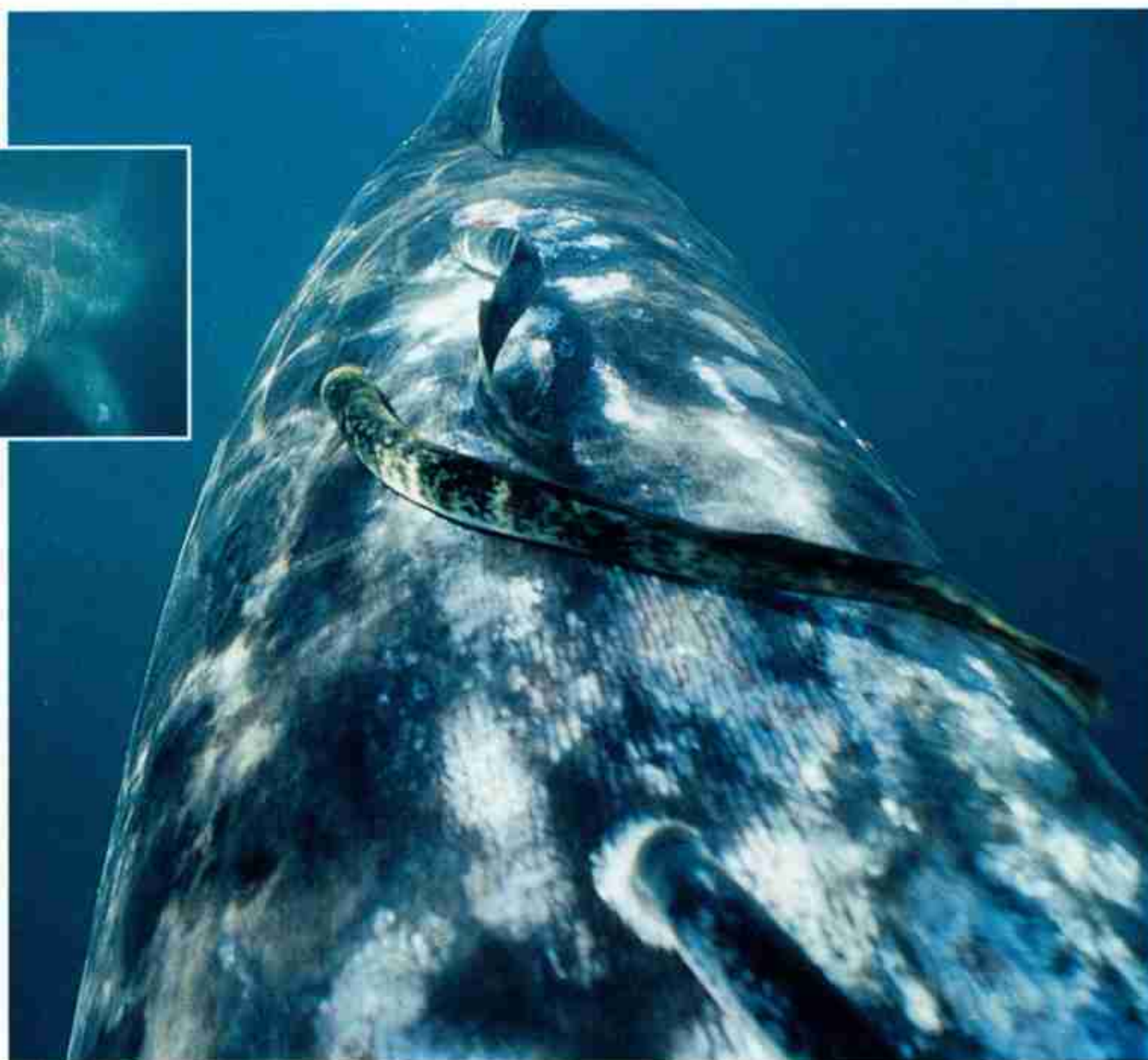
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Parasites Deal With a Nasty Shark Meal

Averaging 25 feet long, basking sharks feed on plankton in Canada's Bay of Fundy. Last summer photographer Jonathan Bird discovered eel-like bloodsucking lampreys attached to several of the behemoths. He contacted researchers Michael Wilkie and Stephen Turnbull, the first to study this behavior. Lampreys parasitize sharks by feeding on their tissue, which contains high concentrations of toxic urea. How do the lampreys handle such a foul feed? "We think they excrete the urea at incredibly high rates," says Wilkie.



BOTH BY JONATHAN BIRD, OCEANIC RESEARCH GROUP

Versailles Rallies From a Big Blow

These trees from France's Château of Versailles survived the French Revolution and two World Wars but were no match for a storm that struck last December 26. Winds of 100 miles an hour destroyed 10,000 trees in the Versailles area alone. That squall and another one the next day in the south of France wiped out some 270 million of the nation's trees.

Damage to Versailles



RÉMY DE LA MAUVINIÈRE, ASSOCIATED PRESS

is estimated at 35 million dollars, but the lost history is irreplaceable. Eighty percent of its rare groves, planted in the 18th and 19th centuries, were uprooted. "They include a pine from Corsica

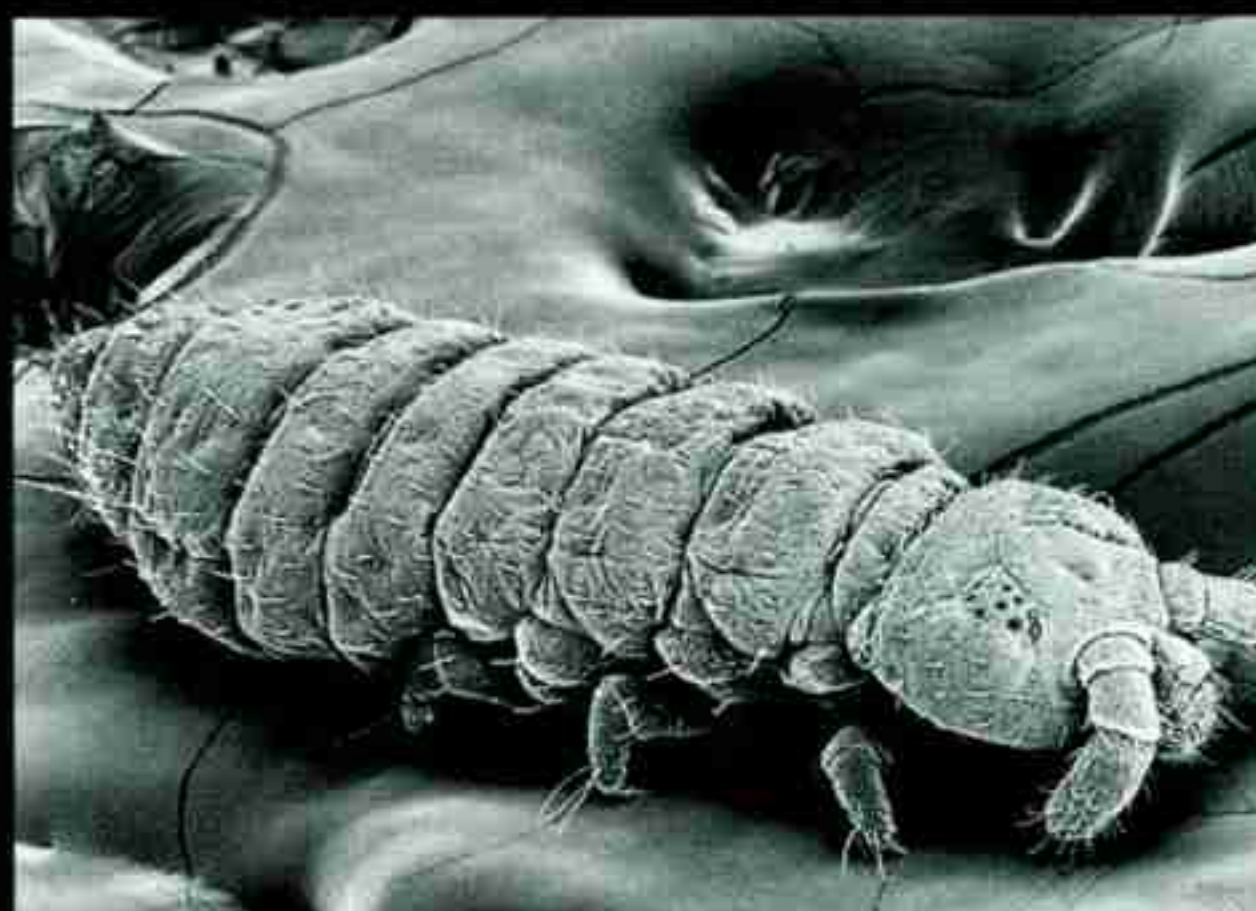
planted during the reign of Napoleon and two junipers planted during Marie Antoinette's time," says Ariane de Lestrangé of the château. More than 5,000 new trees have been donated to begin the long replacement process.

TEXT BY JOHN L. ELIOT

■ NGS RESEARCH GRANT

Chilling Out in Antarctica

The largest land animal that overwinters on Antarctica's Ross Island is a millimeter-long arthropod called a springtail. How? It produces antifreeze, New Zealand zoologist Brent Sinclair and his colleagues have found. In winter the antifreeze allows springtails to survive temperatures of minus 31°F. But in summer their antifreeze supply wanes, and some, artificially cooled by the researchers, froze at plus 21°F and died.



BRENT SINCLAIR AND MATTHEW DOWNES, UNIVERSITY OF OTAGO, DUNEDIN



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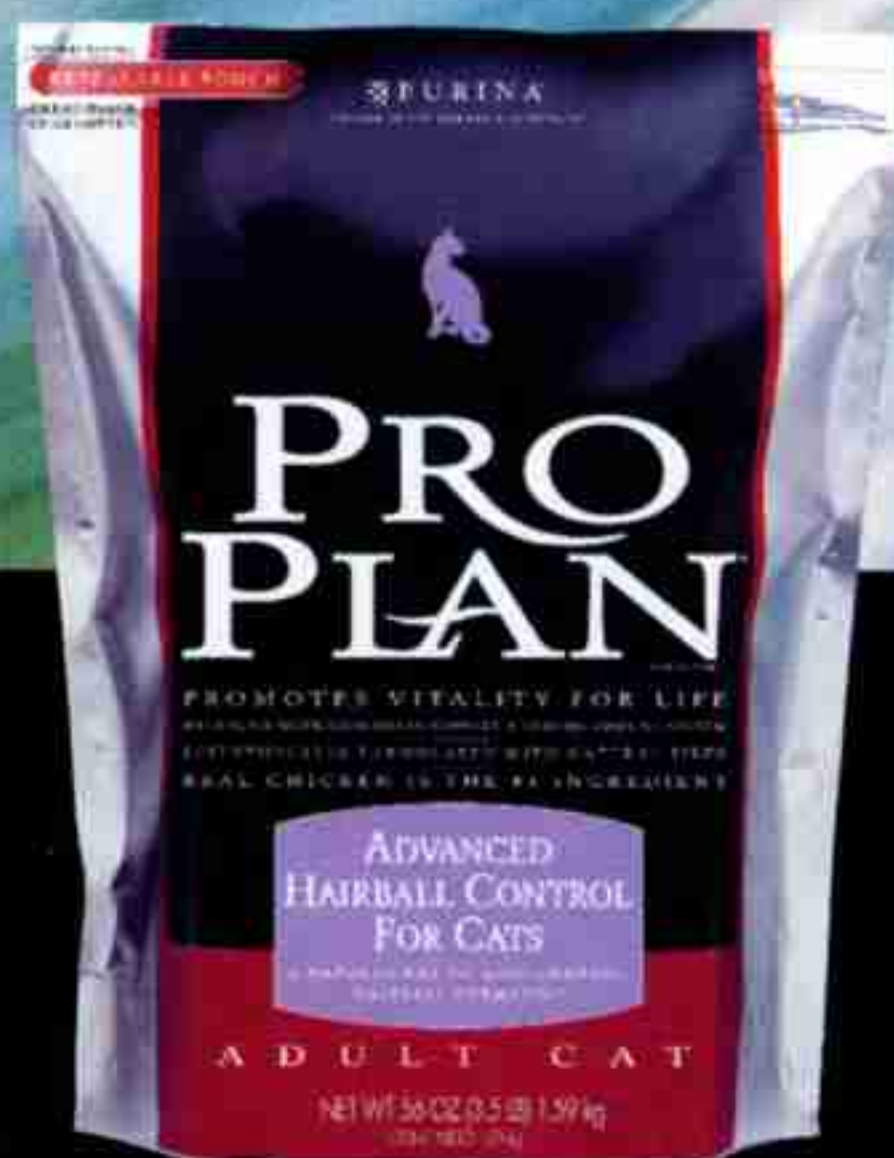
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NATIONAL GEOGRAPHIC



CARY WOLINSKY

From the Editor

LIKE ANTS SCALING A LOAF OF BREAD, tourists troop to the top of Australia's Ayers Rock—despite polite reminders from park workers and tour bus drivers that the rock, known to the Aborigines as Uluru, is a sacred place. Such conflicts between devout locals and ambitious outsiders are not unique to down under. Here in the United States the Park Service imposed a “voluntary ban” during the month of June on scaling Devils Tower National Monument—Mateo Tepee to Native Americans of the northern plains, who hold spiritual rites there at that time and sought to limit the throngs of visitors. Rock climbers sued to overturn the ban, but a federal appeals court ruled against them. As each of us becomes more at home at the farthest reaches of the globe, conflicts like these can only increase. We should develop policies to resolve them now, or we may someday awaken to find a team of tourists rappelling from the Statue of Liberty's nose.

Bill Allen



By **MICHAEL PARFIT**

Photographs by
CARY WOLINSKY

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dramatic,
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magnificent,
unpredictable,
and hard
to manage,
and when
it comes
to protecting it
or using it,
Australia's people
are the same.**

A Harsh Awakening

AUST



Weird as all Australia, the Barkly Tableland is marked by a "cow pad" leading to water. The tableland will get green again with rain, but the continent's strange land and climate have led Australians down a path to environmental trouble.

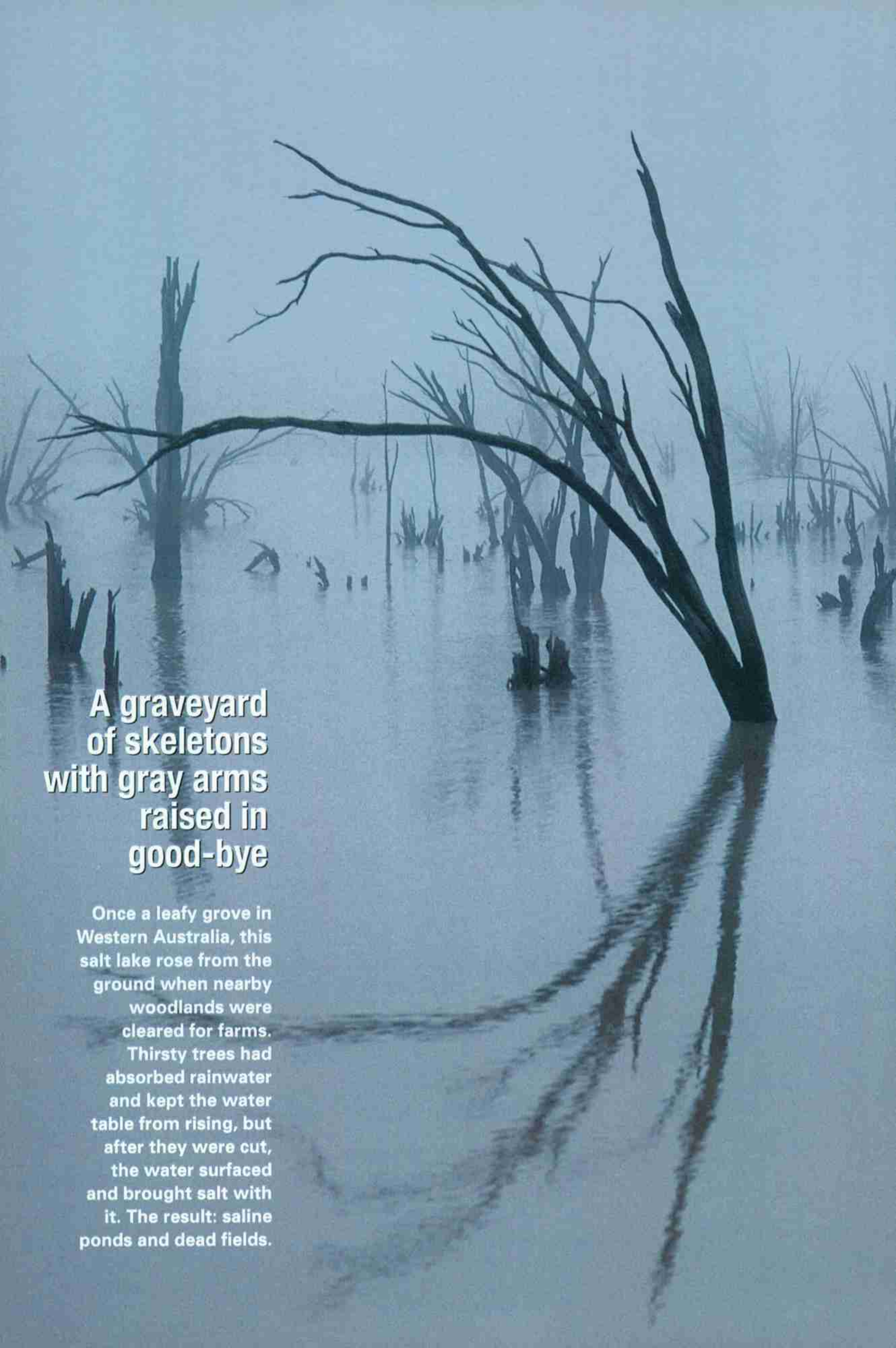
AUSTRALIA



**It looks
innocuous,
but it has
deadly poison
in its skin.**

Warts and all, dead cane toads are turned into paperweights at a taxidermy shop in Queensland. Clothespins keep wet plaster in while it dries. Imported from Hawaii to eat pests, the toads didn't—but their toxic skin killed countless native animals. It's just one debacle in a continent-wide plague of introduced species.





A graveyard of skeletons with gray arms raised in good-bye

Once a leafy grove in Western Australia, this salt lake rose from the ground when nearby woodlands were cleared for farms. Thirsty trees had absorbed rainwater and kept the water table from rising, but after they were cut, the water surfaced and brought salt with it. The result: saline ponds and dead fields.



BELOW THE SMALL PLANE a dust storm rolled over the desert and across the spreading waters of a flood. The dust storm was dangerous. The flood was weird. Australia had done it again. Like a lot of people who had come before, I should have known what might happen. But I didn't, and now I was in trouble.

Flying around Australia is like taking a spaceship to Mars. There's a lot of red sand, and it sure doesn't look like home. I was here to look at that strangeness and its consequences, but now I had blundered into the middle of one of those consequences myself. I was trapped in the air, flying a plane above a storm in which I could not land.

Australia has a veneer of familiarity on its edges—cities, forests, rivers, and beaches—but at heart it is bizarre. That strangeness has led its recent settlers into a rocky relationship with its land. I had come to Australia because a number of environmentalists both inside and outside the country think the continent has been damaged by farmers, loggers, miners, and others over the past two centuries. I had come to see what they were talking about.

And now I found myself in a fix that was symbolic of both the strange nature of Australia and the reasons people have had trouble getting along with it.

Since Australia is almost as big as the continental United States, I'd planned to use a plane to cover 10,000 miles and see much of the continent. I'd studied weather reporting systems, aviation regulations, detailed charts. I'd covered everything, I thought. But I'd forgotten about dust storms.

I should have known that all Australia is prone to flying dust. This is the driest of continents except for Antarctica. And I should have known that the center of the continent averages over five storms a year.

When I headed north from the state of Victoria, fields and woodlands vanished, and flat red rubble stretched ahead into a haze of heat. I flew for hours, watching patterns of stone and sand pass below. Then, suddenly,

MICHAEL PARFIT, a frequent contributor, is working on a TV documentary on his flight around Australia. Photographer CARY WOLINSKY's many GEOGRAPHIC assignments include articles on Australian wildflowers (January 1995) and Joseph Banks (November 1996).

The man from Snowy Trickle, Paul Leete stands where the Snowy River once flowed, holding an old photo of the famous stream. Most of its water was diverted in the 1960s for irrigation and power. To many that was progress, but Leete and other conservationists want some flow restored.



fingers of liquid brown spread out into the red sand, and in the distance sheets of shining water spread along the horizon. Torrential rains had fallen hundreds of miles upstream in the Diamantina River drainage, and now, with no clouds in the sky, the desert was awash.

Then, as if to prove that there is no weirder drama than Australia, along came the dust. Threads of blowing sand gathered under the plane into rolling clouds of grit. I couldn't land. All I could do was press on and hope things would get better. And I thought to myself: I should have known.

That is the story of Australia: We should have known. Much later, long after I outran the dust and landed safely, I walked on a field that was once productive pasture and was now solid salt. I was with a farmer, who said almost the same thing.

"If my father had known what would



happen,” said the farmer, Mike Irvine, “he never would have cleared that paddock.”

Underfoot, salt crunched as we walked.

“Would have been the 1930s, I suppose,” he said. “My father cleared a paddock, got one crop of wheat off it, and the next year it all went salt.”

Behind us a forest of dead eucalyptus trees stood in a salty swamp, a graveyard of skeletons with gray arms raised in good-bye. This place is called a salt scald.

Irvine’s problem with salt may be one of the most dramatic of the troubles that beset Australia today because of things people wish they’d known. Irvine farms 10,500 acres in Western Australia, near Perth. There are shallow layers of salt in the ground here, and shallow aquifers just below them.

When farmers cleared millions of acres of land and the trees no longer protected the aquifers, the water table rose to the surface, bringing the salt up with it.

Today about 10 percent of the wheat belt of Western Australia has been affected by salt, a total of about 4.5 million acres. (Another 1.75 million acres are affected in southern and eastern Australia.) But scientists estimate that as much as 40 percent of Western Australia’s wheat belt may be damaged within a few decades. This not only wrecks fields but also threatens to turn city supplies salty.

Irvine is part of a widespread effort to lower the water table by planting trees, including the oil mallee, a tree closely related to the ones

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human error.**

Irvine's father and grandfather worked hard to clear. A prominent scientist in Western Australia says that only replanting most of the cleared land is likely to improve things significantly. Since that's highly unlikely, it looks as if farmers will have to accept further losses, while cities build diversions and other engineering works to protect their drinking water supplies.

As we walked, Irvine pointed out old sheds, knee-deep in damp salt, where his father once milked cows that grazed on this field.

"If we had our time again," he said so quietly that it sounded like a lament, "we would do it differently."

WHAT MAKES hindsight so poignant in Australia? Perhaps it's that a part of the originality of this continent has been lost to human error. Australia has one of the most biologically diverse landscapes in the world, but that wealth has been eroded.

Australia is the world champion home for marsupials, like kangaroos and wombats; there were at least 144 species here 200 years ago. Today 10 of those are extinct and another 19 are endangered. Fifteen percent of the country's rodent species have also become extinct in the past two centuries. This record of extinction was described by Australia's own State of the Environment Advisory Council as "the worst for any country."

Much of this loss happened because species introduced intentionally or by accident overwhelmed the natives. The country's rabbit infestation is legendary, but among the other animals that have made huge impacts are water buffalo, donkeys, goats, horses, cats, dogs, foxes, and camels. In addition, more than 40 percent of the country's forests have been cleared for farms or by logging, including about 75 percent of the rain forests and 90 percent of mallee and temperate woodlands.

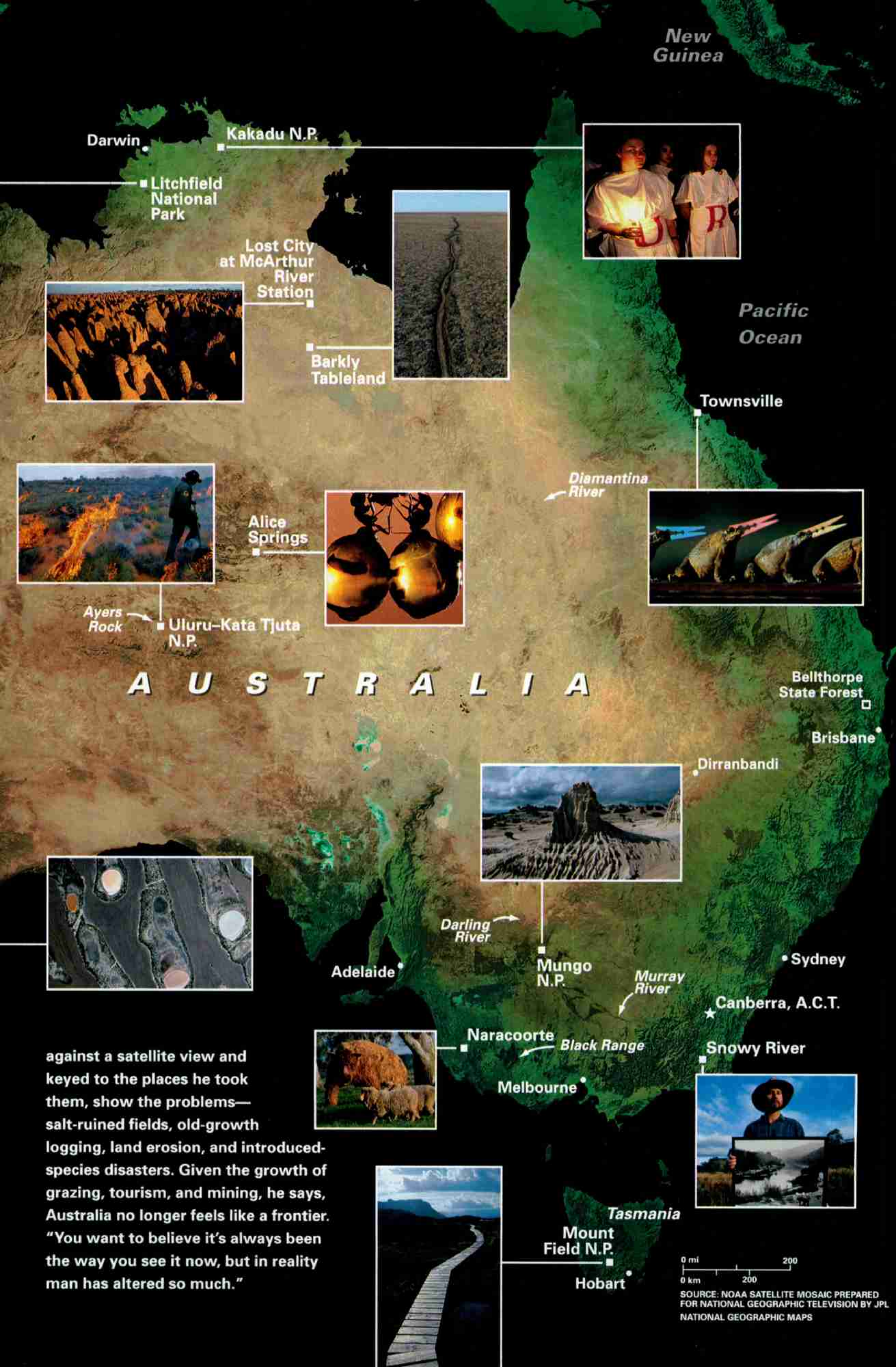
In the mid-1800s societies were formed to make this country look more like Europe, but they succeeded partly in making it look like an environmental mess. Among other things, they introduced sparrows, trout, and salmon, which all competed with natives.

One of the more devastating introduced



Images of trouble and hope

"I've been traveling in Australia for 20 years," says photographer Cary Wolinsky, "and I used to think, What environmental problems?" After a series of troubling journeys around the continent, he changed his mind. Wolinsky's images for this article, shown



New Guinea

Darwin

Kakadu N.P.

Litchfield National Park

Lost City at McArthur River Station

Barkly Tableland

Pacific Ocean

Townsville

Diamantina River

Alice Springs

Ayers Rock

Uluru-Kata Tjuta N.P.

A U S T R A L I A

Bellthorpe State Forest

Brisbane

Dirranbandi

Sydney

Canberra, A.C.T.

Snowy River

Murray River

Mungo N.P.

Darling River

Adelaide

Naracoorte

Black Range

Melbourne

Tasmania

Mount Field N.P.

Hobart

against a satellite view and keyed to the places he took them, show the problems—salt-ruined fields, old-growth logging, land erosion, and introduced-species disasters. Given the growth of grazing, tourism, and mining, he says, Australia no longer feels like a frontier. “You want to believe it’s always been the way you see it now, but in reality man has altered so much.”

0 mi 200
0 km 200

SOURCE: NOAA SATELLITE MOSAIC PREPARED FOR NATIONAL GEOGRAPHIC TELEVISION BY JPL
NATIONAL GEOGRAPHIC MAPS

disasters is the cane toad, a dumpy little hopper from Hawaii intentionally brought to the northeast coast region in 1935 to eat cane beetles. (It didn't.) The toad is moving swiftly across the country. It looks innocuous, but it has a deadly poison in its skin. Some native predators, thinking the toad is a new kind of slow-moving treat, chomp it and die.

What should people have known that might have prevented these disasters? And, more important, what should Australians know to prevent more? As I crisscrossed the continent and talked to people who are asking themselves the same questions, one thing became clear. Australia is raw, dramatic, difficult, magnificent, unpredictable, and hard to manage, and when it comes to protecting it or using it, Australia's people are the same.

"I THINK HUMANS are on the way to extinction," said Mary White, charmingly, over tea and homemade cakes. "I just hope they don't take all the things I love with them."

Mary White, a paleobotanist, is the author of *Listen . . . Our Land is Crying*, which, citing problems like the salt and land clearing, calls Australia "a continent whose health is deteriorating rapidly."

I talked to White in her home in Sydney. Parrots fluttered outside her windows, and a small rat and its baby ate birdseed on her patio.

"What a sweet little bubbly," she said about the rat. White loves the natural world. "I'm not interested in man-made things at all," she said. "It's the nature around that has always inspired me."

White told me to look for clues to Australia's present in the deep past.

"I think in terms of hundreds of millions of years and things changing," she said. "The geologic past predetermined what would happen here when the Europeans came."

So I went looking for the tracks made by millions of years, armed with one last observation: "It's so exciting finding out all this stuff," she said, "that one forgets the awful things."

About 650 miles south I saw tracks of the past in a rain forest in Tasmania. The forest was thick with moss and gnarled trunks but was only about 20 feet tall. I was there with Greg Jordan, a botanist from the University of Tasmania. We were like giants out of a time machine, tromping around a world too patient for the haste of our passage through time.

In the forest was a tree with small crinkly leaves. I had seen leaves just like these on trees in Tierra del Fuego. Related species are found in Australia and South America and as fossils in Antarctica. As we descended deep into this strange little forest, Jordan grinned: "Welcome to Gondwana," he said.

Gondwana was an ancient supercontinent, reconstructed through clues like these trees into a vast piece of land that included Antarctica, South America, India, Africa, and Australia. It began to break up about 160 million years ago. The last connections between Antarctica and the continent of Australia were severed about 50 million years back. After that Australia's landscape didn't do much at all. That's the important part.

"It's a comatose geology," said Tim Flannery, the author of *The Future Eaters*, a controversial look at Australia's environment. Flannery was recently named the director of the South Australian Museum, and I talked to him in his office in



Australia, once part of the supercontinent Gondwana, split from Antarctica 50 million years ago along the southern coast (right). Plants adapted to dryness, like the fossil *Banksia* (above), thrived as the land drifted north. Now its relatives (below) flourish.







Sharing a paddock with the past, sheep meet a model of a diprotodon, one of many Australian species that became extinct after humans arrived perhaps 60,000 years ago. Geologic activity is limited mostly to erosion, which carved this Lost City (right) and has leached nutrients from the continent's soil.

Adelaide. He looked youthfully urbane, out of character with his reputation as an adventurer who has wrestled pythons in New Guinea.

"Ayers Rock would have been recognized by dinosaurs," he went on, referring to the landmark red sandstone monolith that draws tourists to the continent's center. "Australia is about as old as any piece of continental crust gets. It's not like North America, where every ice age remade the face of the continent."

As it drifted north from Antarctica, Australia was like a geologic ghost ship, abandoned by its crew. On other continents mountains were built, then washed away. Volcanic outbursts filled valleys with lava or fertile ash. Rivers carved great ditches like the Grand Canyon, which is only six million years old. But Australia just gradually aged.

Because of this coma, Flannery and many other scientists say, millennia of rain leached nutrients out of soils, salt from sea breezes built up in the ground, and other salts blew across the land from dry lakes in the interior.

"Because of that the Australian continent is extremely infertile," Flannery said. "And it's very delicate."

"It's not surprising that the farmers had real trouble when they first came here," said Neville Nicholls. "They came with all their baggage—mainly from England—about what the climate was like. They recognized that it was hot and windy and dusty, but they took quite a long

time to recognize how big the droughts were and how big the floods were."

Nicholls is a slender, wry doctor of meteorology in Melbourne, who looks both amused and sympathetic about history's goof-ups. Compared with Tim Flannery, he is not an adventurer. "I

don't go to 'interesting' places," he said with a smile. Apparently, his study of climate is scary enough.

Nicholls is one of the pioneers in the study of the global climate phenomenon called ENSO—the El Niño/Southern Oscillation.*

*See "El Niño/La Niña," by Curt Supplee, NATIONAL GEOGRAPHIC, March 1999.

When Aborigines arrived, Australia was populated by a group of megafauna such as the diprotodon—a wombat the size of a rhino.



ENSO is the periodic change of air pressure and water temperature in the Pacific that dramatically affects conditions like storm tracks, drought, and rainfall from Seattle to Lima to Sydney.

"El Niño does not cause everything in Australia," Nicholls said, "but it causes a hell of a lot." Including, for instance, the sporadic floods that hit dry-land river basins like the Diamantina at least once or twice a decade.

Weather statistics don't go back very far. But Australia's plants and animals do. The fact that some of them have evolved to cope with ENSO's moods indicates that it's been going on for millennia.

The widespread arid-land acacia tree called mulga, for instance, can survive for up to 50 years with little rain but requires regular soakings in summer and winter of the same year to reproduce. It gets them only when ENSO brings around the floods. The red kangaroo has its own adaptation: It stops breeding altogether during severe drought.

But with the first serious rains, females begin breeding and produce embryonic joeys even before the older offspring have left the pouch. Unfortunately, it took a long time for European Australians to recognize what the kangaroo and mulga could have told them. Modern environmentalists often tend to ascribe this to thickheadedness, but Nicholls doesn't agree.

"There's no way that Australian farmers are stupid," he said, "and they weren't stupid last century. It's not just Europeans coming in and doing something to destroy the environment. They brought in land-management practices that they thought were appropriate at the time. But they didn't know about El Niño."

Deep in the heart of the continent Mitjili Napanangka Gibson dug in the red sand of the mulga desert north of Alice Springs. Her shovel was a coffee can. Then she reached for a twig and probed gently in the hole. Her old face wrinkled in a smile, but like many Aborigines she didn't make eye contact. She pulled a small golden globe out of the hole and laid it on the sand. The globe was the size of a pearl, but it squirmed. It was a honey ant.

Aborigines did not call the uncertain weather El Niño, but they knew about it. The first

Europeans here thought the nomadic Aboriginal way of life, which involved the use of great varieties of native plants and animals, was primitive. But the original Australians had spent a lot of generations struggling to figure out how to live with this country, and their system was a good way to survive the weirdness.

Mitjili doesn't know when she was born, but she remembers a relative cutting open a tree with an ax made of stone. She was one of the last Aborigines to emerge from the hunter-gatherer way of life. Now she's in her 60s and lives with her daughter and son-in-law in the city of Alice Springs, but she still hunts honey ants.

Australian Aborigines lived as hunter-gatherers for perhaps 60,000 years. But their earliest days may have the most resounding message for the present.

When Aborigines arrived, Australia was populated by a group of megafauna such as the diprotodon—a wombat the size of a rhino—and the giant kangaroo, which was

taller than a human. After the Aborigines got here, these animals became extinct. Did the Aborigines kill them? Tim Flannery thinks so.

It's a much debated theory, but if it's true, Flannery argues, you can draw a parallel between that spasm of death and the species extinctions and environmental disasters brought by the Europeans in the past 200 years. Flannery's argument is clear: The Aborigines diminished the land's bounty, then had to adapt to survive; the same thing's going on today.

Mitjili dug about 50 honey ants out of the hole in the sand. She gestured at me to taste one. With trepidation I sucked on the globe. It burst into my mouth, sweet and tangy. She did not look at me, but she smiled.

IT IS EASY TO SAY, "I should have known." But my experience with the dust storm had given me a good dose of Australian reality: This place is hard to predict, harder to understand. As I flew back and forth across the country, aware of the silent depths of its geologic past, of its fickle climate, of its fragile wealth of biodiversity, I thought those things might clarify today's issues. But they only show

**"If we had our time
again, we would
do it differently."**

—MIKE IRVINE, *Farmer*

where mistakes were made, not necessarily how to avoid error today. Every new choice seems different.

Not too long after I had walked on the salt fields on Mike Irvine's farm, I sat in a car in Queensland, on the other side of the country, with Henry Crothers, while a D-9 bulldozer he'd hired rumbled its way across land that had recently been woodland. He had made a decision like Mike Irvine's father had. He was clearing the paddock.

While I was in Australia, land in Queensland was being cleared at an estimated rate of 840,000 acres a year—more than one and a half acres a minute. It was one of the highest rates of land clearing anywhere in the world. Some, like 900 acres of Crothers's land, was going into irrigated cotton.

Yet Australia's past suggests that further clearing of land might be a mistake. "It's absolutely scandalous," Mary White told me. But to me it didn't look that straightforward.

Henry Crothers knew all about this opposition. "With all the talk about the environment," he said, "if you're not aware of it, you're a bloody idiot." To him and his community this was not a disaster. It was the opposite—it was a reprieve from oblivion.

Towns are fading away all over rural Australia, which has lost nearly 500 branch banks in the past five years. Since 1997 bad farm debts in Queensland alone have grown from \$506,000 (\$311,300 U.S.) to \$4,435,000.

"When the 1965 drought came, the wool prices were already down," Crothers said as we drove through the small town of Dirranbandi. "We lost a lot of people, and they took houses away. Until irrigation. The difference between our town and a lot of others is that because of irrigation it's come good again."

But because of irrigation, river waters are being stretched thin.

Henry Crothers's new cotton farm, with its two 500-million-gallon reservoirs, is in the basin known as the Murray-Darling drainage. I'd already been down to the mouth of the Murray River, south of Adelaide. The drainage basin that fills the Murray is among the largest in the world, but almost nothing flows out of the mouth. I had walked across a kind of weir called a barrage and watched a modest roll of brown water tumble through a gate about 12 feet wide. The rest of the water had

evaporated upstream or been used by cities or for irrigation.

Partly because of that irrigation, the Murray-Darling Basin is in a state of perpetual trouble, with salt incursions, toxic algal blooms, and dwindling flows. On occasion the Murray has even stopped.

Yet who would not be proud to help life come back to their town? "Things are happening," Crothers said. "People are painting, they're putting fences up, they're creating employment, they're bringing in houses."

Only a short time ago this area was arid ranchland. Now it looks like the Imperial Valley of California. But no one can be sure if this is the making of a farming empire or the start of something as bad as the Dust Bowl.

"What can we do?" Crothers asked. "If people in the inland can't make a dollar, what do you do with the land when they're all gone? It's sort of a two-edged sword, I guess. So far, I don't think we've done anything wrong. Not seriously, anyway."

No one can challenge that statement with certainty. Environmentalists say that farmers are asking for a salt disaster in Queensland, but landforms here have different drainage patterns and different soils from those where the salt's bad. The bottom line is that there is not enough information to know whether this is tragic or farsighted.

"We badly need scientific proof of these things that are worrying us," Mary White told me. "We need somebody to do an eight-year study. Why isn't the information really there to tell us whether we are right or not?"

A recent report assessing the nation's environment strikes a similar chord: "Compared with other developed nations, Australia has only rudimentary information on the condition and productive capacity of its land."

In other words, what we should have known, we don't yet know.

“IT’S LIKE YOU’RE REALLY A PART OF something,” said Stewart Paton. He was sitting by a campfire in southern Western Australia with several young men and women, including one who said his name was Schroom Inappropriate Moondog Pooh Bear. They ranged in age from 16 to over 30 and were there to stop logging. They wore shabby clothes and smoked

An aerial photograph of a savanna landscape in northern Australia. The ground is covered in dark, dense vegetation, likely grass and low shrubs. Scattered across the landscape are numerous termite mounds, which appear as light-colored, irregular, and somewhat rounded structures. Some mounds are isolated, while others are clustered together. Small, young trees with green foliage are also visible, growing sporadically among the mounds. The overall scene depicts a healthy, functioning ecosystem where termites play a crucial role in soil nutrient cycling.

Flying around Australia is like taking a spaceship to Mars.

A wad of soil, a bit of spit—that's what termites use to build mounds like these in northern Australia. Feeding on grass and plant litter, termites recycle nutrients and help replenish the soil. It's a vital ecological task, especially because the continent's lack of geologic activity has left much of the land nutrient poor.



hand-rolled cigarettes, and they knew, with vivid passion, exactly where they stood. This was a scene from the most angry environmental battle in Australia—the fight over logging.

“You travel around and draw on the energy wherever you are,” Paton said. “It becomes an addiction. This is like a religion. I can go over east and the same thing will be happening. There will be a fire, and people sitting around talking about these things.”

We were deep in a forest of enormous eucalyptus trees called karri. They are among the giants of the eucalyptus family and can stand nearly as tall as redwoods. The people around the fire were what Australians call “ferals.” The term normally refers to the many domesticated species that have gone disastrously wild here. But recently it’s been applied to environmentalists who live out in the forest on donations or social security checks, blockading roads or perching on platforms to fight the timber industry. The camp was here because the karri trees were scheduled to be logged.

Australia’s forests are tiny compared with its deserts. When Europeans first came, only 9 percent of the land was forest; that’s down to about 5 percent today. The logging of these forests, and particularly of shrinking stands of old growth, has been fought over for decades. The sale of old-growth wood chips to Japan for paper has been particularly controversial. The sides of the debate seem permanently divided, as much by philosophy and emotion as by facts.

On the environmentalist side people get an emotional or even spiritual attachment to a forest or to individual trees. “I’ve seen people go hysterical watching trees come down,” said Tom Whitaker, president of the South Coast Environment Group. “It’s probably the equivalent of watching your family getting shot before a firing squad.”

Yet the hardworking culture of loggers has emotional roots that are just as strong. After my night with the ferals I visited a nearby logging site. Six men sat around in drizzle in a lean-to, barbecuing beefsteaks and sausages for lunch on the surface of a wood-burning stove. Not one would ever say, “I feel strong and complete and more of a man when I’m working in the bush,” but I knew that was how they felt.

“These attacks on good, hardworking people undermine their self-worth and their pride,”

“They’re sweet with a gritty zing,” says author Michael Parfit after sampling some honey ants. The insect has long been a part of the diet of certain Aborigines, whose knowledge of local ecology is a newly valued asset. Without it, says environmental historian Tim Flannery, there is “no guide as to how humans can survive long-term in our strange land.”



said Jeanette Sturis, a resident of the timber town of Manjimup. “I get a spiritual connection too; I go to church and connect with people. I have no problem with people having a connection with a tree. But it *is* just a tree.”

IN THE CLAMOR of conflict over the land of Australia, are there voices of resolution, of hope? Yes. They’re not loud, but they’re there. Well, that’s not quite correct. Pete Speldewinde’s voice is loud. It carries through the acacia scrub on the Peron Peninsula 450 miles north of Perth, where there’s an experiment in recovery.

“When a woylie is small,” Speldewinde said, booming, “it’s quite nice. It’s just a bundle of fur. Once it gets bigger, it’s all teeth and claws.” Woylie is the Aboriginal name for a brush-tailed bettong, a marsupial slightly smaller than a rabbit, whose numbers



have been decimated by foxes and feral cats.

Speldewinde is a biologist for Western Australia's Department of Conservation and Land Management (CALM). The agency developed a program called Project Eden, which is designed to clear the peninsula of feral animals and restore native species. The idea of fencing off a chunk of Australia for protection is not new. There are dog fences* and rabbit fences in other parts of the country, and there have been other efforts like Project Eden to revive endangered species by killing ferals. But this is probably the largest and best financed. Not only has CALM put in an estimated three million dollars so far, but private sponsors like a grocery chain are also involved. The chain gives

a percentage of its take in selling chocolate "Easter bilbies" as part of an Australian effort to replace the bunny with something that doesn't symbolize destruction.

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Project Eden appears to be working. Not only are the original fauna recovering, but so too is much of the vegetation.

"Don't let that cute face deceive you," Speldewinde said, grabbing a leg. "See that claw? Not very pleasant." He was holding the back leg of a woylie he'd just trapped.

Speldewinde, who was surveying the woylies on the peninsula, wielded calipers and read off measurements in millimeters. "Scrote,

*See "Traveling the Australian Dog Fence," by Thomas O'Neill, NATIONAL GEOGRAPHIC, April 1997.



**It looks as if
farmers in
Western
Australia
will have
to accept
further losses
of land.**

**A problem, in pastels:
Farmers struggling
to make marginal
lands more productive
apply fertilizer, which,
when it runs off into
salt ponds, feeds
colorful colonies of
algae. To stop salty
groundwater from
seeping into the top-
soil and ruining it,
farmers plant trees—
but many landowners
are still losing ground.**





Angry about logging, which with farming has reduced forests from 9 percent of Australia's land to 5 percent in the past 200 years, Leith Maddock and Sky Hawk mourn a fallen karri tree. Kevin Briand roosts in a standing one to protect it. Such squatting is illegal, but, says one activist, "It's like saving your child."

twenty-six point eight," he said. No wonder these animals are a little testy, I thought.

Project Eden has been going on for six years. It started with an electric fence across the isthmus connecting the 405-square-mile Peron Peninsula to the mainland. After the fence was built, CALM started trapping and killing goats, foxes, and cats. Today cat numbers are reduced, goats are fewer, and the foxes are nearly gone. Woylies, the first species released here, seem to be surviving.

I couldn't help feeling hopeful, though it's a long leap from 400 square miles to a feral-beleaguered continent. These little animals are not exactly equivalent to the megafauna that once roamed the land, but helping woylies get back on their nasty clawed feet is not a bad symbol of adaptation.

Speldewinde was done measuring the woylie. He put the sack it was in on the ground. The woylie stuck its head out warily. Cute! Big eyes, pointy little nose. Then it launched an absolutely astonishing leap that must have taken it 15 feet into the brush and was gone.

"It's a great project," Speldewinde said. "It's like having your own Lego set. You've got something broken, but you've got these building blocks. So you work out what went wrong, fix that, and then rebuild the ecosystem. There's not many places in the world you can do that."

He shoved aside sharp branches. There was another trap ahead, with a woylie clanging

around in it, eager to get back to rebuilding Eden. Speldewinde shouted over his shoulder, "I think it appeals to my megalomania."

Later, in Queensland's Bellthorpe State Forest, I walked with Aila Keto on what will no longer be a logging road.

"This is what I love," said Keto, walking through the forest. "Just looking up." It had seemed the longest odds that I would find resolution in a timber fight, but here it was.

Like Western Australia, Queensland has been mired in forest politics, with much bitterness. But both Keto, who runs the Australian Rainforest Conservation Society, and the forest industry wanted to try a new way out of

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But it is just a tree."**

—JEANETTE STURIS, *Logging town resident*



the mess. Up to then federal and state governments had been trying to hammer out agreements through a lengthy bureaucratic process run by government agencies. Keto and the industry tried to avoid that.

"We used a process never before thought of by the bureaucracy," she said, "with no support from the bureaucracy." It involved direct negotiations between people like Keto and Rod McInnes, who represents the Queensland Timber Board.

"Aila and I circled each other at ten paces for quite a while," McInnes told me later. "Then over four years we developed a pretty healthy respect for each other's point of view—though we didn't necessarily agree."

"We tried to avoid tree sitting and blockading of roads," Keto said. "Our philosophy is to try to rationally resolve conflict. Trust building is part of it. It has to be put in a moral context."

The context was not just moral. It also came back to the issue that frustrates Mary White: information. One of the keys, Keto said, was that all groups accepted the same set of facts. McInnes agreed. The timber industry, he said, decided not to dispute the meticulous inventory of species and unique sites Keto and her colleagues had put together during the years of negotiation. Their work showed the value of biodiversity and the ways it can be maintained, such as the need for protected areas to be sufficiently large. And the environmentalists agreed to accept the economics of logging that indicated some of the small towns in the region were threatened. "We knew the agreement had to provide a solution to both," Keto said.

But even with that unusual level of cooperation, the plan almost fell apart at the end. Unable to come to a final agreement, the two sides backed away, reverting to the kind of accusations and anger that I'd seen so vividly in Western Australia.

"In a way maybe that's part of the process," McInnes said. "In order to prove to each other that you weren't prepared to cave in, you had to go out and do a bit of tub thumping. Then we thought, Well, crikey, is this really going to get us anywhere? And then, given that we'd both said we weren't going to budge, we sat down and did budge."

The agreement was signed last September. It provides for the conservation of large tracts of forest and guarantees resources to most of the

Badlands in Mungo National Park were created by drought and erosion, worsened by park visitors and foraging kangaroos. This corrosive mix—of natural and human forces—has wreaked havoc across Australia, but with little public awareness until recently of the causes or the cures. It has been "a pattern of denial," says one scientist.



sawmills for the next 25 years, while the government helps develop a logging industry based on plantations, mostly on previously logged land or land once cleared for farms.

"It was a very good conservation outcome," Keto said. "And it offered a resource security for the mills that they had never had before. It was a sort of classic win-win solution. I firmly believe there are strong lessons here that would apply elsewhere."

To McInnes the precedent didn't seem as clear, partly because Queensland's issues differ from those in Western Australia or Tasmania. For instance, Queensland does not have a big wood-chip industry.

"It would be nice to say that this is a role model," McInnes said. "Unfortunately, the dynamics are unique. But that doesn't mean that industry people and conservation people shouldn't sit down and talk."



I'LL ALWAYS THINK of Rob Youl with the red juice of fresh mulberries running down his chin and dripping on his shirt. He didn't care. That stuff was good. "We're starting to turn the tide by making people passionate about local vegetation," Youl said after cleaning up. Youl works for a program called Landcare, which links farmers and, increasingly, urban people in an Australia-wide network that seeks to recover from land disasters of the past and adapt to the future. We were visiting the western part of the state of Victoria, where Landcare has been so successful that it's spawning international copies.

Landcare is a voluntary program. Mary

White, who's skeptical about some efforts to fix environmental disasters, calls it "marvelous," because it so obviously engages individuals.

"We've got a bit of a tradition in Australia of seeking to educate rather than legislate,"

Youl said later. "We want to develop commitment rather than resentment. All part of our democratic ethos, I guess."

Landcare focuses on the planting of trees, the fencing off of rivers from livestock, the controlling of soil salinity, the saving of bits of

bush. It is not flamboyant. The most vivid mark of Landcare I saw while driving and flying around with Youl was an array of old milk cartons standing in rows for a quarter mile along a road. The cartons protected new trees.

"They brought in land-management practices that they thought were appropriate at the time."

—NEVILLE NICHOLLS, *Scientist*

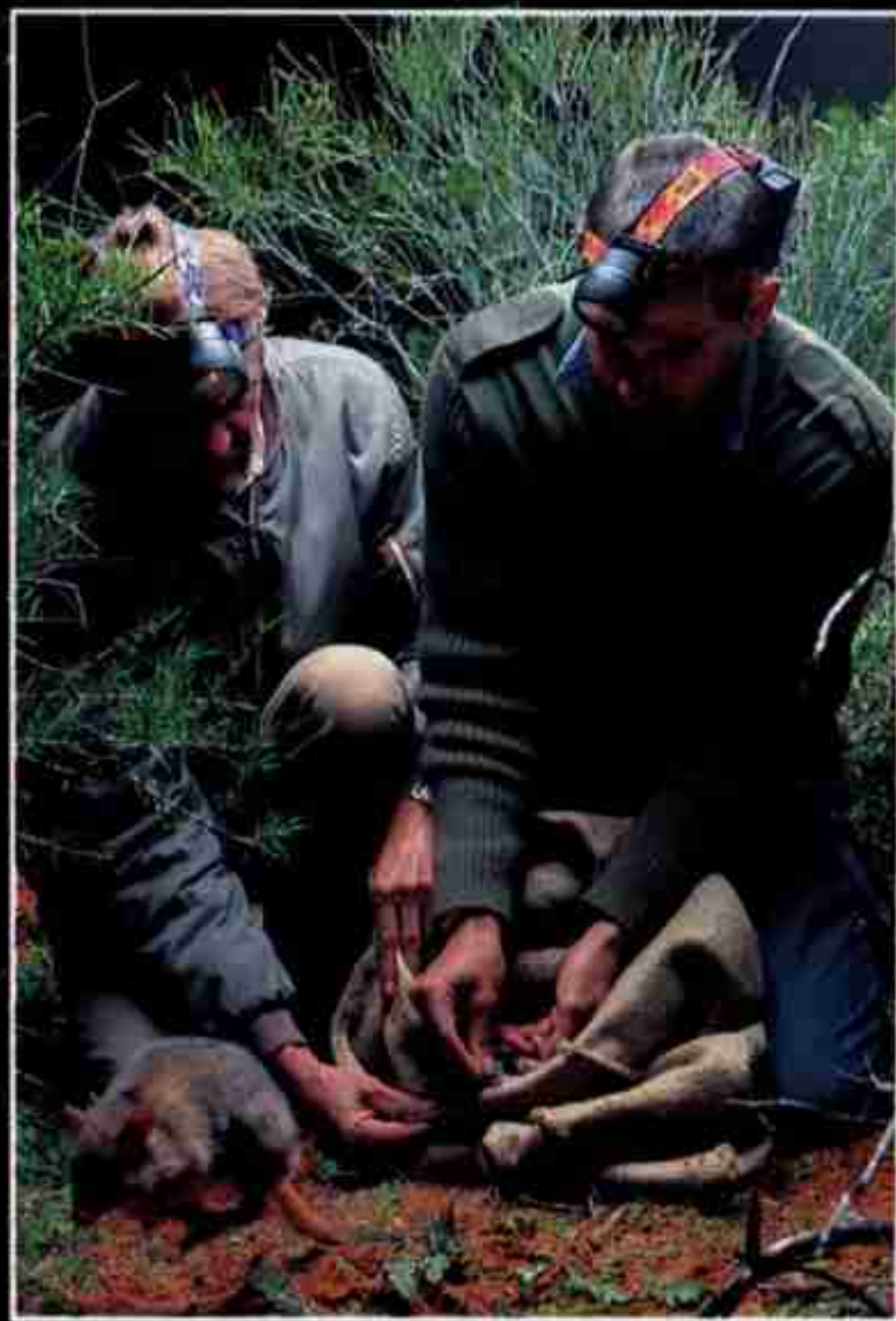


Starting to turn the tide

To protect cushion plants but still show off their beauty, managers at Tasmania's Mount Field National Park built this boardwalk. From farmers voluntarily planting trees to groups protecting endangered species, Australians are getting the message. "Environmental awareness as a community standard has only occurred in Australia since the 1980s," says farmer Gus McGown. "Now those of us who live in the landscape have to be a lot smarter."



"First you think it's an impossible job," says biologist Pete Speldewinde (right, at right), releasing a brush-tailed bettong on the Peron Peninsula (above) in a species-recovery program. The big hurdle is financial. "If we get the funds," he says, "we can do it."



Fire, used for millennia by Aborigines to open up the landscape for game, flares in a "patch burn" set by an Aboriginal park ranger.

Sprig of hope—a Melaleuca sapling—is patted into place by five-year-old Calum Membrey on a farm in Western Australia. Calum's grandfather is a member of Men of the Trees, one of many groups focused on bringing native vegetation back to cleared lands. Tree-based land recovery is promising, says forester Rob Youl, "but it's a slow process. We've got to aim at the next generation."



Youl is cheerful, optimistic, and indefatigable. I got a sense of the scale of Landcare in Victoria when he rode in the plane with me between the towns of Hamilton and Nhill, which are about a hundred miles apart. He narrated the whole trip. He seemed to know each row of trees. Everywhere someone was practicing Landcare.

"This is called the Black Range," he said, pointing out low forested hills. "The Landcare group here is trying to connect the Black Range with the Dundas." Another hill passed. "They started about 17 years ago. Now you can see how that shelter belt links with that bit of bush there, and that bit of bush there, and so on. They've done it."

Landcare rumbles up into national prominence once in a while with an event like a TV personality's challenge that resulted in the planting of a million trees in a week, or a recent Olympic Landcare operation in which people from coast to coast got out to plant trees one weekend. But most of the time, Youl says, "It's just a gradual process. Not spectacular, but it's fun, and it seems to be working. It reaches further all the time, by quantum leaps and quantum creeps."

In the face of all the grand problems of Australia, what good is a widespread but quiet program like Landcare? Maybe its very modesty offers the most hope. Spectacular things

A story of time told in stone, layers of quartz and iron oxides make footholds in Karijini National Park. Among Earth's oldest outcrops, the rock of this region is coveted by mining interests. A proposed uranium mine within another park, Kakadu, provokes a protest (below)—yet one more flash point in the struggle over Australia's fragile magnificence.





don't last; they're like fireworks. But the Landcare program is quietly working its way into the Australian culture. "Landcare's become a social thing now, like churches or schools," one farmer told me.

We landed and visited a farm managed by a man named Bruce Milne, who is planting trees, fencing off bush and waterways, and watching birds and wildlife return. As we crossed a field, an echidna—a small, spiky anteater that resembles a porcupine—scuttled out in front of us, then did an amazing thing. With little apparent effort it wiggled itself down into the loose dirt of the pasture and disappeared.

I think of Landcare as a bit like an echidna. Someday it will dig down so far into the culture that it will seem to vanish. You see that happening already, as other groups with different names but similar structures and goals are

formed all over Australia. Perhaps Landcare will disappear precisely because it will have changed the culture itself, adapting everyone a little better to the difficult but rewarding land that is Australia, and there will be fewer times when people have to say, "I should have known."

On the farm, we left the vanished echidna and drove on past groves of trees and pastures full of sheep.

"I'm a pessimist," Milne said. "An honest look says things are really, really crook, and this country and others are not facing up to it. But it's important to see the things you can do."

Rob Youl wanted me to be a bit more optimistic. "We're taking a much longer view now," he said. "I think that's what matters." □

Can environmental concerns and commercial needs find common ground? Comment online at www.nationalgeographic.com/ngm/0007.

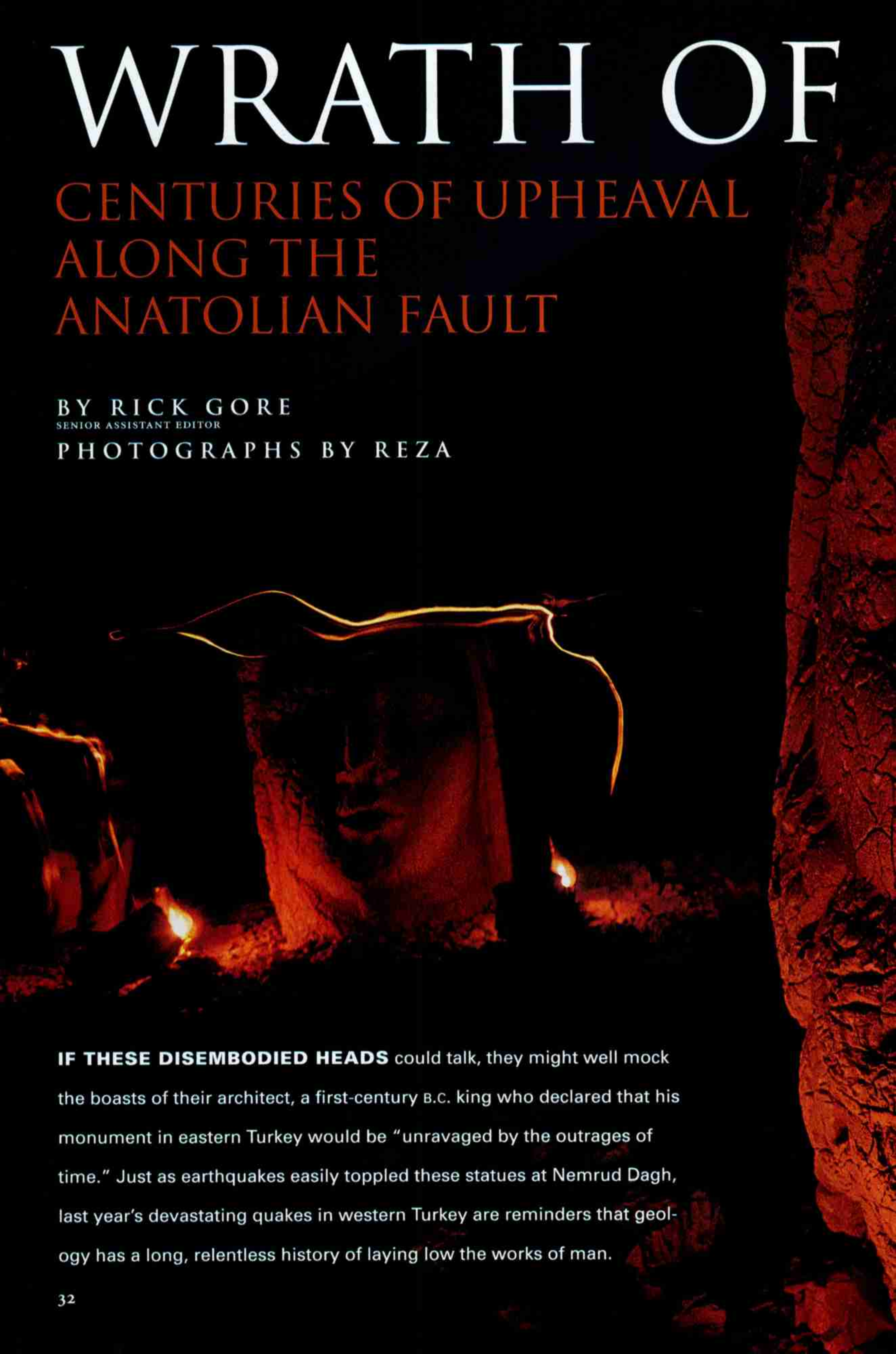
WRATH OF

CENTURIES OF UPHEAVAL ALONG THE ANATOLIAN FAULT

BY RICK GORE

SENIOR ASSISTANT EDITOR

PHOTOGRAPHS BY REZA

A dramatic photograph of ancient stone statues at Nemrud Dag, Turkey. The statues are partially buried in a thick layer of dark ash or sand. The scene is dramatically lit from below by a fire, casting a strong orange and red glow over the entire scene. The statues' faces are visible, though somewhat obscured by the ash and the lighting. The background is dark, making the illuminated statues and the fire the central focus of the image.

IF THESE DISEMBODIED HEADS could talk, they might well mock the boasts of their architect, a first-century B.C. king who declared that his monument in eastern Turkey would be “unravaged by the outrages of time.” Just as earthquakes easily toppled these statues at Nemrud Dag, last year’s devastating quakes in western Turkey are reminders that geology has a long, relentless history of laying low the works of man.

THE GODS



HIS WORLD IN SHAMBLES, Mehmet Kamişoğlu commiserates with a nephew and a passerby in front of the building he lived in—and escaped from—in Gölcük. Last August 17 the segment of the North Anatolian Fault that runs under this city



produced a magnitude 7.4 earthquake, shattering the booming industrial region of northwestern Turkey. Cheaply built apartments that housed the recent influx of workers collapsed, killing thousands and leaving many more homeless.



EARTHQUAKE IN TURKEY

THE NIGHT WAS TOO SULTRY for sleep. So at 3 a.m. on August 17, 1999, restless townspeople in Gölcük, Turkey, strolled in

the park. They walked along the waterfront on the Gulf of İzmit, easternmost arm of the Sea of Marmara, and perhaps some talked of the many jumping fish spotted on the coast in recent days—or of the mysterious appearance of dead crabs and jellyfish. But İsmet Koyun and six other members of a local soccer team reminisced about past games as they sat on benches beneath a willow tree.

“Let’s go home,” İsmet recalls saying. “I’ve got to work today.” As he stood, an explosion boomed over the gulf. “The earth came alive with shaking,” he says. “The sky turned red, a sword of light flew out of the sea, and a wave as tall as a ship thundered toward us.”

A great crack opened along the waterfront, and “like a drunk man trying to run,” İsmet leaped over it and raced inland. Three of his friends climbed trees. A blinding storm of dust from collapsed buildings rose over the town and swept down toward the shore.

When the dust settled, İsmet found himself knee-deep in water. Looking back, he saw that a vast section of the former waterfront, including the park, had slumped into the gulf, sinking 30 feet or more. The lower floors of two seven-story buildings had crumbled and plunged into the gulf, killing 50 men who had been gambling in a ground-floor café.

Like everyone I met along the Sea of Marmara in the days after the earthquake, İsmet Koyun still seemed stunned as he sat on his bicycle and looked out at the submerged trees



AKE

FORTY-FIVE SECONDS of shaking ravaged Adapazarı. Though the fault passes about five miles to the south, the city's loose alluvial soil amplified the motion. Concrete, loaded with sand to cut costs, crumbled; steel reinforcing rods, scandalously thin, buckled.

and lampposts now well offshore. "Many bodies remain out there under the water," he said. "Also many vehicles, including a police car with two policemen inside."

Gölcük lies near the epicenter of one of the most punishing earthquakes of the past century. The magnitude 7.4 catastrophe created headlines worldwide. Tens of thousands dead. Some 250,000 homeless. And billions of dollars' worth of damage to Turkey's industrial heartland.





Istanbul, a city of more than seven million people about 50 miles northwest of the epicenter, was violently shaken. Although the heart of the megalopolis remained intact, the quake destroyed several dozen buildings in Avcılar, a neighborhood built in recent decades on the western edge of the city. And thousands of people, too frightened after the quake to sleep indoors, camped in open spaces with tents thrown together from sheets, towels, and blankets.

"This tragedy has directly touched almost everyone in the country," said my Turkish friend Aydin Kudu. "Hundreds of thousands of people from all over Turkey had moved here for jobs. We've all lost someone."

The earthquake began just east of Gölcük, about ten miles underground along a buried rip in the Earth's crust known as the North Anatolian Fault. Extending from eastern Turkey to Greece, the thousand-mile-long rip is very similar to California's infamous San Andreas Fault. Like its American counterpart, the Anatolian Fault is actually a network of smaller fault segments that divide two tectonic plates—in this case Eurasia and the much

RETURNING TO TRADITION to feed their families, women in Cevizlik take homemade bread dough to be baked in a neighbor's old stone oven. On November 12 the fault ruptured here, dropping the road several feet and triggering another large quake. Damage blocked commercial food deliveries for ten days.

smaller Anatolian block, which carries most of Turkey on its back.

The edges of the two plates are locked together, but geologic forces are driving the Anatolia plate westward toward Greece at the rate of about eight or nine feet a century, building pressure along the juncture. When enough pressure builds, one or more fault segments unlock in a violent jerk. If a small segment breaks, the ensuing earthquake might be magnitude 6 or less. But when the segment beneath Gölcük snapped, the energy released triggered ruptures along three adjacent segments—to both the east and west—creating a much larger event.

Three days after the earthquake struck, I drove with Aydin toward the epicenter, reading the morning headlines. The official death count had reached 6,800. Three provincial governors—unable to coordinate initial relief efforts—had been replaced. Rescue workers, including at least 2,000 foreigners, were giving up hope of finding anyone else alive in the

REZA, a native Iranian who lives in Paris, covered the Caspian Sea for the May 1999 GEOGRAPHIC and the Black Dragon River for the February 2000 issue.

wreckage. In the city of Adapazarı 963 people had been buried in a mass grave. The Turkish government was ordering 10,000 more body bags. The destruction of the infrastructure of one of the most industrialized regions of the country was “complete,” said the general secretary of the Foreign Investors Association.

When we reached the edge of İzmit, the largest city hard hit by the earthquake, the smell of petroleum pervaded the air. Black smoke still billowed up from the Tüpras refinery complex, Turkey’s largest. People walked the highway with suitcases. Relief workers carried corpses to an ice rink that had been converted into a morgue.

We came to an immense pile of broken concrete—the remains of a six-story apartment building. Carpeting, bedspreads, and splinters of furniture protruded from the rubble. A rescue team working with a large backhoe picked away at the debris pile.

Clustered around the collapsed building were scores of people, their eyes red, their faces weary. Many clutched photo albums or stared at pictures of loved ones, hoping against all odds that they might still be breathing beneath the concrete.

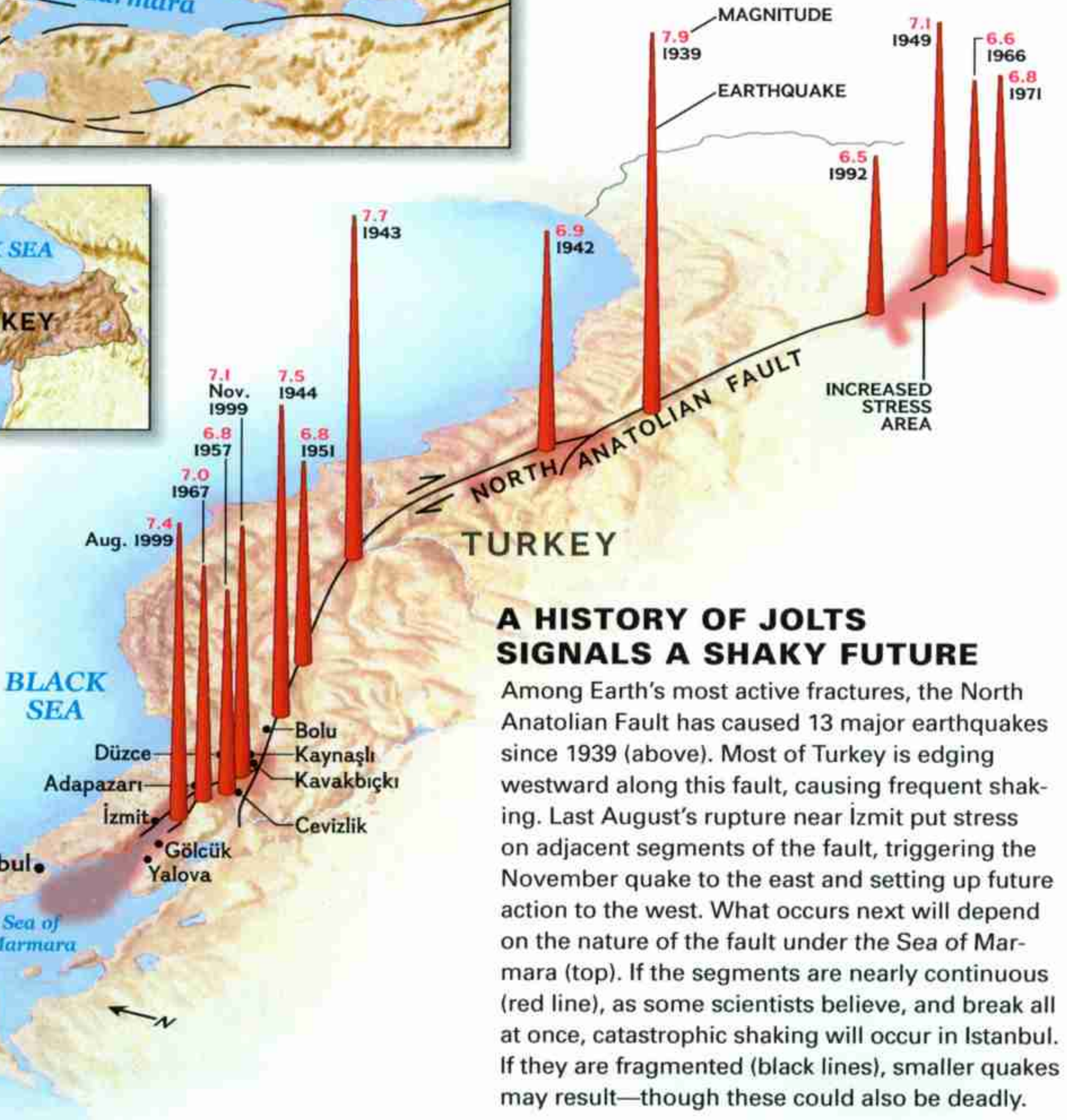
A shout arose from the rescue team—a body. The workers carefully extracted the corpse of a woman; people crowded around. No one recognized her.

“It’s hard,” said a bystander. “The faces are so swollen and black.”

I felt intrusive and helpless. “What can I say to these people?” I asked Aydın. “*Geçmiş olsun*,” he replied. “May it be over.”



SOURCES (TOP):
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A HISTORY OF JOLTS SIGNALS A SHAKY FUTURE

Among Earth’s most active fractures, the North Anatolian Fault has caused 13 major earthquakes since 1939 (above). Most of Turkey is edging westward along this fault, causing frequent shaking. Last August’s rupture near İzmit put stress on adjacent segments of the fault, triggering the November quake to the east and setting up future action to the west. What occurs next will depend on the nature of the fault under the Sea of Marmara (top). If the segments are nearly continuous (red line), as some scientists believe, and break all at once, catastrophic shaking will occur in Istanbul. If they are fragmented (black lines), smaller quakes may result—though these could also be deadly.

BRICKWORK CRACKED in a park near Gölcük as the underlying sediment slid toward the Gulf of İzmit. The fault that lies about half a mile offshore here also passes less than 15 miles from Istanbul. But much of that city sits on bedrock,



which offers some measure of stability. "Sediment shakes much more strongly than bedrock," explains James Dolan, a University of Southern California geologist. "Sometimes five to ten times more, so it's not a trivial matter."



An older man with bandaged head and arms arrived, and people rushed to greet him. He was Mustafa Çifttepe, one of seven people who had survived the collapse of the building. His wife and son had not. He was just back from the hospital.

"He was trapped for 17 hours," said his son-in-law, Ersin Güzey, who lives in New York City. As soon as they heard of the catastrophe,

apartment. "This building had only half the steel it should have had," he said. "And this is supposed to be concrete," he said, dropping a chunk and watching with disgust as it shattered into bits. "It's more like sand."

Vedat's anger echoed across Turkey as the death toll mounted. The dire need for housing during recent rapid urbanization had encouraged fast, shoddy construction in thousands



Ersin and his wife had caught the first flight available to Istanbul.

Ersin translated his father-in-law's story: "I was in bed with my wife on the second floor when the shaking began. My wife said: 'Get up! Get up!' Then a large chest landed on her. A wall fell toward me, stopping two inches from my nose. I was afraid to move, afraid if I did, everything would collapse and crush me. I just prayed and called for my son."

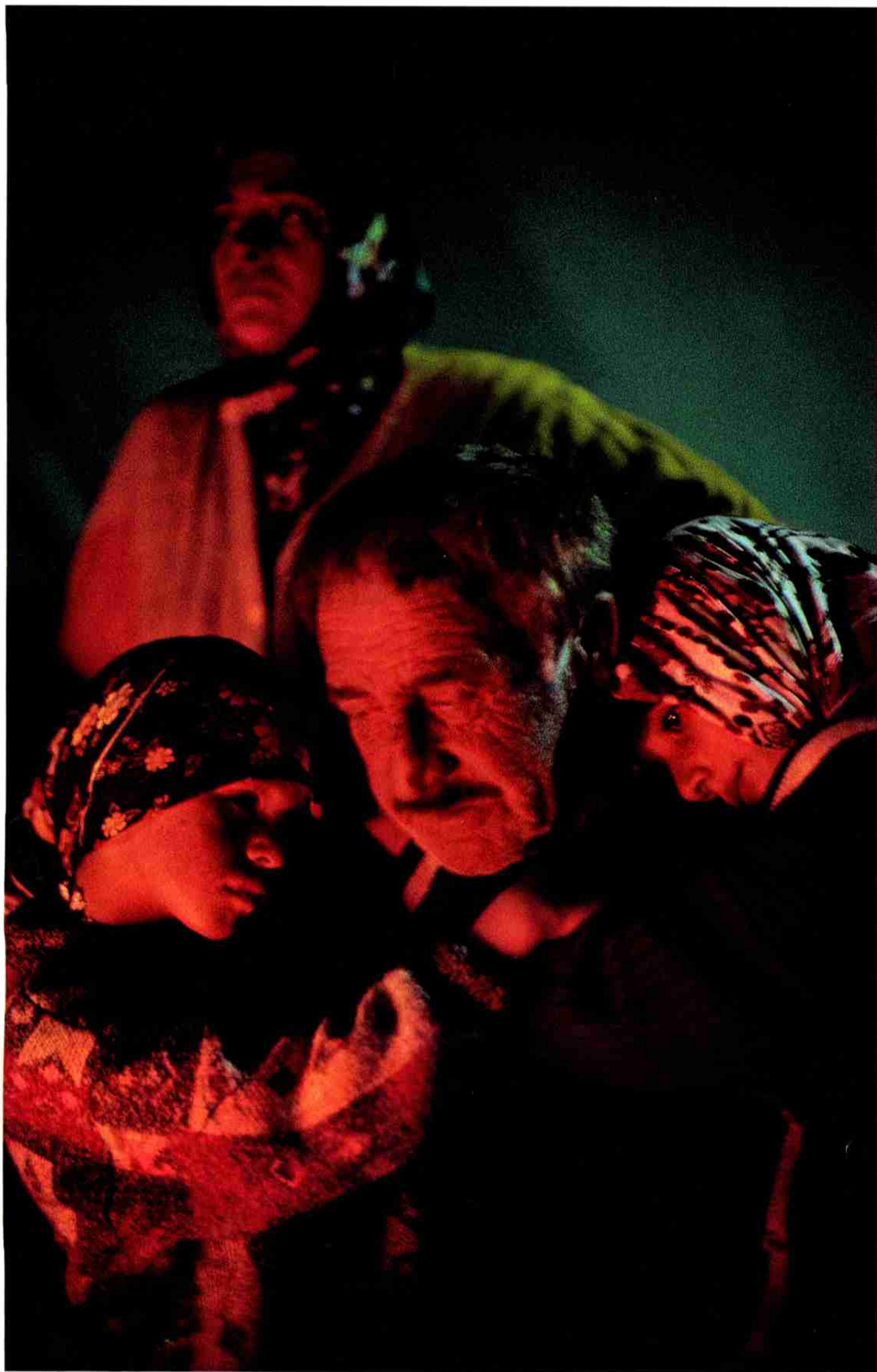
His son, a neighbor named Vedat Aktaş told me, was found crushed in the next room, his pants pulled halfway up his legs.

Vedat cursed the contractor who built the

A BABY'S CRY guides a Japanese rescue team as they dig through the ruins of a home in Düzce. After eight hours they reached the tiny girl, but she had died. A bonfire warms homeless survivor Ayşe Gonca (standing), her daughter, father-in-law, and niece. "May God save my enemies from such destruction," she says.

of new buildings. Many contractors, either through corruption or negligence, ignored building codes designed for earthquake resistance. It was those newer buildings that took the greatest hit.

As we left, I turned to the bandaged old man: "Geçmiş olsun." He nodded, his eyes filling with tears.



WE HEADED DEEPER into the destruction zone, giving a ride to a man bound for Gölcük. His niece and her husband had died there, and he wanted to search for other missing relatives. The sun blazed. The air sweltered. And everywhere I looked I saw the heaped remains of countless shattered stores, mosques, and apartments. Most of the buildings still standing teetered on the brink of collapse. Traffic inched past bulldozers working to clear debris. Thousands of sweating, overworked rescue workers attacked concrete rubble with jackhammers. The smell of death filled the air, and, like most of the people we saw, we put on surgical masks to filter the dust, odors, and microorganisms.

Aydin and I stopped to let our hitchhiker out and met two schoolteachers—a husband and wife—sitting in a field surrounded by an upholstered couch, a dining room set, and various other pieces of furniture they had retrieved from a nearby apartment building. They pointed to where they had lived.

“We were on the fifth floor,” said Gönül Güzel. “Now it’s the third. The top floors fell into the first two. Everyone on the bottom died.”

“I WAS AFRAID TO MOVE, AFRAID IF I DID, EVERYTHING WOULD COLLAPSE AND CRUSH ME.”

“We have no idea what will happen to us,” said his wife, Yücel. “People bring us food, but we have no desire to eat.”

At the resort town of Yalova we met a friend of Aydin’s named Hakkı Akyazı. His eyes were swollen, and in a soft, slow voice he told us he had just buried his sister, a medical doctor who had lived in a new apartment complex there. The two had been on vacation together on the Aegean. She had decided to extend her stay and had returned to Yalova for the night to pick up more clothes.

When Hakkı heard of the earthquake, he



rushed to her building, which lay in ruins. No rescue teams had reached it. He figured out where her apartment would have been and for 12 hours worked alone to get inside her bedroom. When he finally did, he found her dead.

At dusk we took a ferry from Yalova back to Istanbul across the Sea of Marmara. As we left the dock, I watched dump trucks pull up to the shore and empty the rubble of so many lost lives into the water. There was no other place to put it. Our boat was packed with mourners, and the setting sun turned the water deep red. It seemed as if we had been to a thousand funerals all in one day.



THE WALK HOME after a doctor's appointment takes Mehmet Karabulut over a toppled minaret in Cevizlik. When the shaking started, he was in a café with friends. Bricks and ceiling beams buried him, breaking four ribs and hobbling a leg. "The grocery store I ran is in ruins too," he says. "I'm thinking of raising cows."

The next morning we visited Istanbul Technical University to speak with geologists struggling to understand exactly what had happened along the North Anatolian Fault.

"We knew that the Gölcük area was where the fault was likely to break next," said Rob Reilinger, an American geophysicist from MIT. Reilinger uses the satellite-based global

positioning system (GPS) to track deformations or swellings of the Earth's surface that indicate where pressure is building underneath. "We just didn't know when this earthquake would happen or how much of the fault would break."

Scientists are able to explain some earthquake phenomena that puzzled the people of Gölcük. The flash of light that İsmet Koyun saw over the Sea of Marmara may have been methane gas exploding as it was released from sediments in the gulf. The dead crabs and jellyfish seen at Gölcük could have been killed by radon gas seeping from rock in the Earth's crust into

WATERFRONT PROPERTY NOW, a popular ice cream parlor in Gölcük used to sit well back from the Gulf of İzmit. When the fault broke here, land along two miles of this coast fell ten feet or more, and water flooded inland. Several thousand



people drowned or were crushed as buildings disintegrated. Since then, survivors who lost their homes as well as those seeking a safer place to live have moved elsewhere, and the city's population has dwindled from 80,000 to 25,000.





the water just prior to the rupture.

But there is much the scientists still do not understand, and much that disturbs them. This earthquake, explained geologist Aykut Barka, was part of a sequence that began along the North Anatolian Fault in 1939 near its eastern end. Historically each section of the fault in Turkey breaks on average every several hundred years. Before this earthquake the only stretch of the main fault that had not broken in the 20th century extended from the city of Bolu, about 90 miles east of Gölcük, to the western end of the Sea of Marmara—a distance of about 220 miles. The four fault segments that broke on August 17 account for only about 70 miles of the 220 at risk. This earthquake probably pumped additional strain into unbroken segments.

Most worrisome are about a hundred unbroken miles of the fault that lie deep beneath the Sea of Marmara, passing less than 15 miles from Istanbul. Scientists do not understand well the structure of that obscured stretch, but they know it poses dangers. Nicholas Ambraseys, a specialist in historical earthquakes at Imperial College in London, notes that 40

THE LIVING AND THE DEAD share the hills south of Gölcük. In a makeshift cemetery wooden markers bear the names of loved ones lost. Fifteen-year-old Adem Yılmaz (right) was more fortunate: All his family members survived. But they are among the half million people made homeless by the two quakes.

earthquakes of magnitude 7 and above have hit the Marmara region since the first century A.D. In 1509 and again in 1766, great earthquakes destroyed much of Istanbul. Both may have been part of a 250-year rupture cycle. Some experts now argue that one or more events at least as large as the August quake will occur in the sea south of Istanbul in coming decades.

How bad might the next Istanbul quake be? That depends in part on how far the epicenter is from the city. It also depends on whether the fault segments beneath the Sea of Marmara break together or independently. Together they could create an earthquake as strong as magnitude 7.8—about four times stronger than the August earthquake.

A week after the earthquake I received permission from the Turkish Navy to walk where the North Anatolian Fault did some of its most spectacular damage: the Gölcük Naval

Command Center, the largest naval base in Turkey. When the quake tore through the Gulf of İzmit, it devastated the compound, toppling buildings and killing hundreds of people.

"I've been in many earthquakes, but nothing like this," recalled Ercüment Doğukanoglu, a naval captain. "When it hit, I felt helpless—like being thrown every which way in a frying pan."

Heavy rain fell as a young second lieutenant, Selçuk Poyraz, led us across the ravaged base. "The rain is nice," said Selçuk. "It washes away the smell of death, which gets into everything. I have to put cologne in my car, on my clothes."

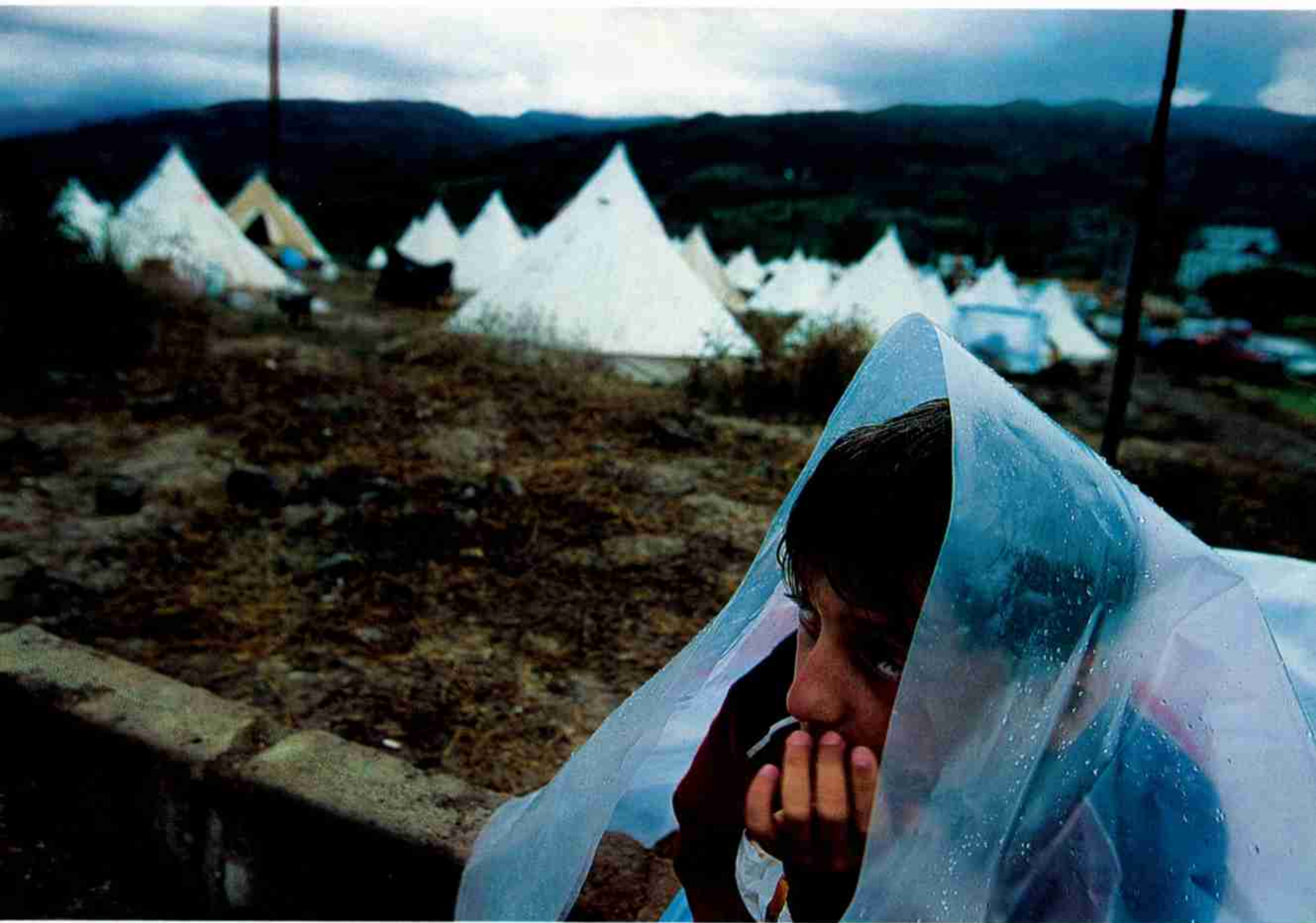
He walked us to a green lawn and pointed at what looked like the burrow of a gigantic mole cutting across the base, creating a scarp several feet high. In its path lay the ruins of an officers' club, where scores died in their sleep.

We followed the burrow until it opened into a crack so wide I had to jump to cross it. We reached a place where the crack had split a stone wall, thrusting the south end eight feet to the west into the middle of the street it once bordered. The same crack also pushed an

entire apartment building across the street several feet closer to Greece.

AS THE EARTHQUAKE FADED from the world's headlines, its miseries persisted. I returned to Turkey in late October. The official death count stood at just over 17,000, but the real toll may have been twice that. Winter was setting in, and although people were being fed adequately by organizations such as the Red Crescent, warm clothes remained in government warehouses undistributed. With more than 85,000 buildings destroyed or uninhabitable, about 40,000 families were living in 168 tent cities. Few tents were winterized.

Psychological problems were mounting. Many men remained jobless and idle. Many of the neighborhood coffeehouses they relied on for socializing were gone, replaced by scattered coffee tents. Children played and attended school in severely overcrowded tents. So many teachers died in Adapazarı that in one district only two remained to look after 2,000 children.



As a group, the women displaced from their homes may have been suffering the most. “They have no place to go to be together,” said Mebuse Tekay, a relief coordinator for 128 nongovernment volunteer groups.

Despite the crisis, Mebuse pointed to positive changes the earthquake brought.

“It has collapsed some taboos,” she said. “Many Turkish people thought they had no friends in the world except other Turks. But so many foreigners came to help us, we now must see a new reality. Even the Greeks proved not

On a cold and drizzling December morning I met 15-year-old Özgür in the nearby village of Handanoğlu, where he was living in a tent with surviving relatives. As I talked with the men of the village in the parlor of a farmhouse that had survived the quake, Özgür sat silently by the stove, warming his hands. He smiled occasionally but mostly stared vacantly ahead.

“These earthquakes are tests from God,” said Mehmet Bayındır, a wizened 92-year-old. “We should build houses the old way—from chestnut wood. They don’t collapse.”

His grandson Hüseyin agreed. “I accept that this was a geologic event, but it can be taken as a warning. In seconds,

MANY CONTRACTORS IGNORED BUILDING CODES DESIGNED FOR EARTHQUAKE RESISTANCE.

to be our enemies. Television showed a Greek team crying after they rescued a little girl.

“Also many of the people rushing to help were from arts groups. Now many traditional Turks have had to change their biases toward men who have long hair or earrings and women in miniskirts. It was those people who showed up first.”

On November 12 the North Anatolian Fault struck again. Stress from the August quake triggered a rupture along a segment of the fault east of the earlier break. The second quake measured magnitude 7.1. It hit a much less populated region but still killed more than 800 people and injured at least 5,000.

In the town of Kaynaşlı, Özgür Akbulut’s father and older brother had just left evening prayers at the mosque when the temblor hit. As most of the town’s buildings buckled, the mosque’s towering minaret crashed down on the two men, crushing them to death.

A LATERAL RIFT that opened under a house in Kavakbıçkı in the November quake did little damage because diagonal wooden beams absorbed the shocks. Unlike the village’s three ruined concrete buildings, such traditional homes safely withstood the shaking—as they have for centuries.



billionaires can become penniless. So you must have values that you can't lose—a good heart and honesty.”

Although smaller, Kaynaşlı looked like Gölcük all over again—streets lined with shattered buildings and mournful people struggling to rebuild. I headed back to Gölcük, about 80 miles away, to see how people there had coped in the intervening months.

The nightmare hadn't gone away. Bulldozers had cleared most of the piles of rubble, and temporary prefabricated houses had risen rapidly outside the town. But Gölcük itself was still a city in shambles. I found İsmet Koyun again in a coffeehouse by the waterfront.

“There's not much else to do,” he said as we drank tea with his friends. “Gölcük is dead. Most people have left. The government hasn't decided whether the city should be rebuilt.”

At dusk, İsmet took me to the water's edge, where he had watched his city collapse. We clambered over twisted rebars and mud-caked chunks of concrete to the seven-story building where the 50 men had perished in the sunken café. We watched the water lap into what had been the building's third floor.

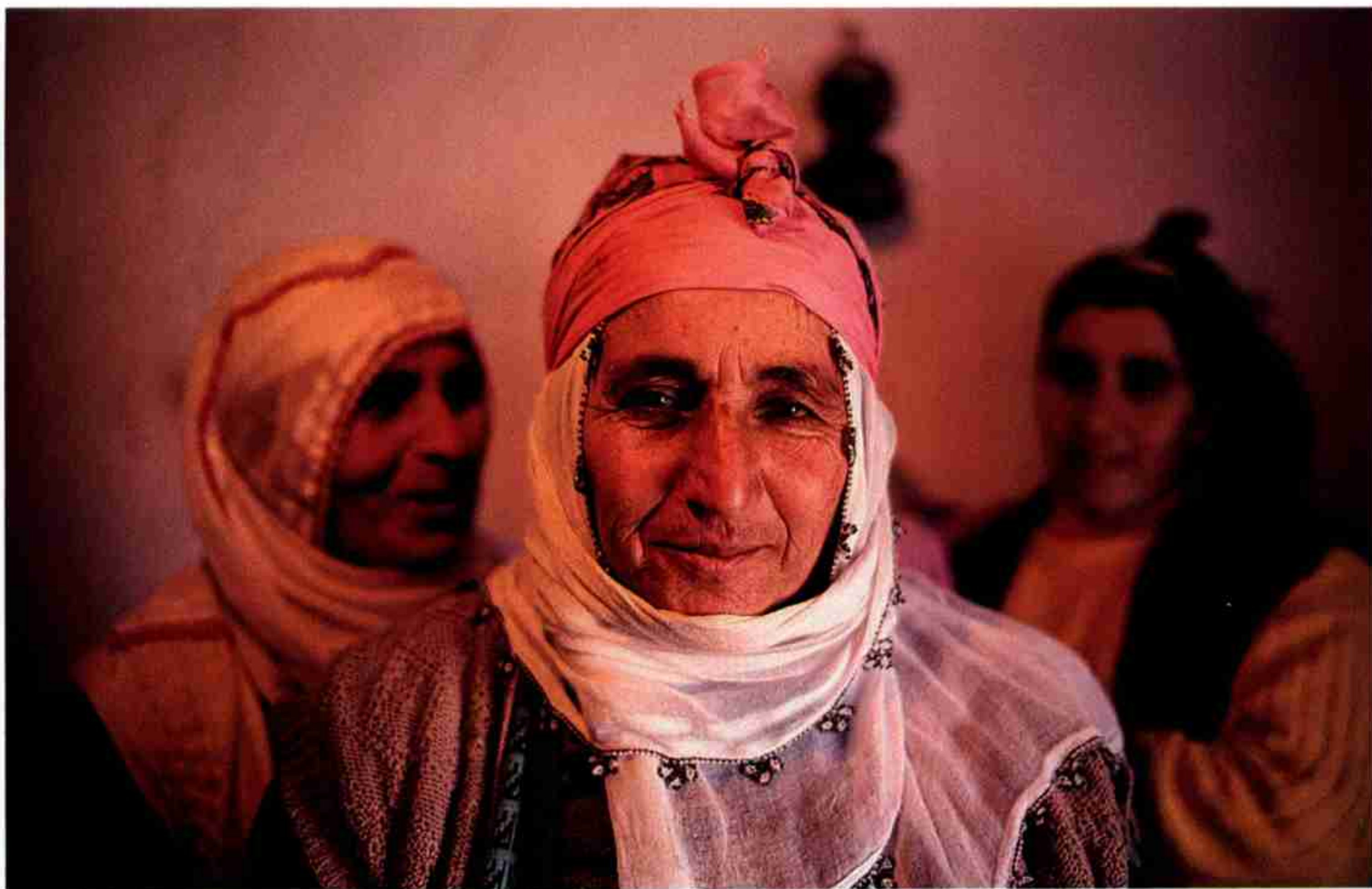
“Thirteen bodies were never found,” he said. Darkness fell, and I could only think of one thing to say: “Geçmiş olsun. May it be over.” □



A HISTORY FORGED BY DISASTER

CROSSROADS of both peoples and tectonic plates, the Anatolian region is rich with stories of cultures accommodating themselves to a violent geologic landscape. Near the modern city of Van in eastern Turkey, remnants of an Ottoman castle cover the ruins of fortresses as old as the ninth century B.C. Strategically set on a hill created by colliding plates, the castle overlooks the Middle East's second largest lake, 75-mile-long Lake Van, formed when a volcanic eruption blocked rivers' flow.





HEARTACHE HAS FOLLOWED ME from the rubble piles along the Sea of Marmara to a bleak and rocky landscape in eastern Turkey. *Geçmiş olsun*—"May it be over." I've said that phrase so many times to survivors of the killing earthquakes near Istanbul. But, in fact, I know what no one wants to hear: It will

never be over. Nowhere have civilization and nature waged more persistent war than in this part of the world—from easternmost Turkey to the western tip of Greece.

In the first century B.C. a self-absorbed king named Antiochus I, ruler of the ancient land of Commagene, built an audacious tomb and monument to himself on top of a 7,000-foot-high mountain called Nemrud Dagħ. There, he proclaimed, his mausoleum would be "unravaged by the outrages of time."

He constructed a conical tumulus more than 200 feet high from fist-size rocks, hauled up and assembled with unimaginable labor. On terraces around the tumulus stood a pantheon of colossal statues—gods and heroes with whom he expected to consort in the afterlife.

No doubt Antiochus's understanding of geology was as flawed as that of the driver who is now transporting me in his *dolmuş* from the Turkish town of Kâhta to Nemrud Dagħ. Gesturing toward a cluster of oil wells on the rocky landscape, the driver declares: "That's why we

have earthquakes. They are pumping out the oil and the land collapses."

I nod, knowing I could never convince him how little power human actions have over the titanic forces of the Earth—even with the abundant evidence I find a few hours later at the pinnacle of Nemrud. The tumulus has shrunk to 150 feet as rocks have tumbled down the mountain. And someday—an instant from now in geologic time—the king's tomb will be gone, his coffin laid bare by the ravaging tremors he thought he had risen above. I pause before great stone heads of Zeus, Heracles, Apollo—and of the vainglorious king himself. All these constructs of human imagination are laced with cracks or toppled on their sides. Surrounding me are the constructs of geology, the real ruler of this land—limestone and shale that formed at the bottom of a deep marine basin and that, over time, were pushed up into mountain ranges. Even Antiochus's statues were carved from uplifted limestone.

Humans in this part of the world have long

blamed the Earth's sudden and violent changes on supernatural agents. In 464 B.C., when an earthquake destroyed Sparta and provoked an uprising of serfs, the ancient Greeks blamed Poseidon, the earth shaker. And just last year, after an earthquake devastated suburbs of Athens, a priest at the monastery of St. Kyprianos told me the catastrophe was a divine warning: "It was sent to shake us from our sins."

Rob Reilinger, a geophysicist at MIT, provides the scientific explanation—"There's a full-scale continental collision going on," he says, "where Africa and Arabia are driving north and colliding with Eurasia." That collision, which has continued over the past five million years, creates a complex pattern of geologic processes that fascinate scientists just as they mystified and devastated ancient cultures.

The collision began in eastern Turkey and affects most of Anatolia, the peninsular part of the country. Arabia, which is moving north slightly faster than Africa, hit first, and when it shoved into the underbelly of Eurasia, it

thrust up not only Nemrud Dagħ but also the Caucasus Mountains.

The collision has thickened the continental crust in eastern Turkey, now about 30 miles thick, compared with some 25 miles thick farther west near Ankara. As a result the region, which lay near sea level before the collision, is now a plateau averaging more than a mile high. In some places jagged remnants of ancient sea-floors that once lay between the colliding continents jut from the compressed landscape as mountains. Most of the rock in those seafloors, however, was pressed down toward Earth's mantle. This stimulated melting and the formation of magma that resurfaced through cracks to form volcanoes such as Mount Ararat, the fabled final resting place of Noah's ark.

Almost 17,000 feet high, Ararat, flanked by its smaller sister, Little Ararat, dominates vistas along the Turkish-Iranian border. No wonder the ancients believed that this ice-crowned massif would be the first land to emerge from a great flood. But today the legends that

have surrounded the mountain are forgotten by residents of Doğubayazıt, the nearest town—charmless, commercial, and ravaged by years of Turkish-Kurdish conflict.

KURDS HAVE LIVED in southeastern Turkey for more than 2,000 years—still not long enough to verify the tale that Noah's ark came to rest on Mount Ararat (below, left). Though Kurds live and tend sheep in sight of the dormant volcano, the last village on its flanks was lost to an earthquake in 1840.





HERE HUMANS AND THE FORCES OF GEOLOGY HAVE COEXISTED HARMONIOUSLY AND SPIRITUALLY.

"People in the town don't know anything," says a local hotelier, Feyyaz Salman. "But my 110-year-old grandmother, who lives in a nearby village, told me the two mountains were sisters who hated each other. Little Ararat cursed her big sister, saying 'May you grow so tall you will always have snow on your head.' In turn, Big Ararat cursed her little sister: 'May you always be so close I can control you. And may you always have snakes in your hair.'"

Neither volcano has erupted in recent memory, but residents of eastern Turkey have much to fear from earthquakes. The compression resulting from Arabia's northward thrust is pushing Turkey westward in jolts, like fingers squeezing the pit from a cherry.

No city in Turkey has suffered more pain from earthquakes over the centuries than the ancient metropolis of Antioch. In A.D. 115 the Emperor Trajan blamed an earthquake that destroyed the city on the presence of Christians and had the bishop, Ignatius, thrown

to the lions. Walls fell again in A.D. 458. In 526 an earthquake killed 300,000 people, according to the historian Procopius. His figures are exaggerated, but other crushing earthquakes occurred the same year. Plague hit in 542, Persian armies in 573. Another earthquake in 588 closed a devastating century.

Modern Antakya, on the site of the ancient city, still falls victim to frequent earthquakes. A third of Antakya was leveled in 1872. Geologists know that the city lies near the junction of three major faults, including one slicing up from the Dead Sea. So why do people continue to rebuild here? It's a crossroads, say some. The climate is mild and the soil is rich, say others. "We've always lived with risk," adds businessman Joseph Naseh. "If it wasn't earthquakes, it was invasions."

Indeed, invasions have been almost as common as earthquakes in Anatolia. And ironically, violent Earth forces have actually helped people in the heart of Turkey protect themselves against raiding armies. In a region called Cappadocia fiery surges of volcanic ash, cooled and sculpted by erosion over the past few million years, have covered the ground with blankets of rock so soft that humans could cut sanctuaries—even entire secret cities—into them when faced with invading hordes.

"Cappadocia coming (*Continued on page 64*)



VIOLENT GEOLOGY isn't always the enemy. In central Turkey's Cappadocia region—a thoroughfare for Persians, Romans, Byzantines, Arabs, and Turks alike—people once sought refuge from invaders by digging into soft volcanic rock. The rock erodes quickly except where protected by harder rock, producing formations resembling minarets (top). Hundreds of early Christian churches and dozens of underground cities have been found in Cappadocia, including one that is 20 stories deep. Most caves now sit empty, though some have been upgraded for modern life.

THE CRADLE HAS ROCKED

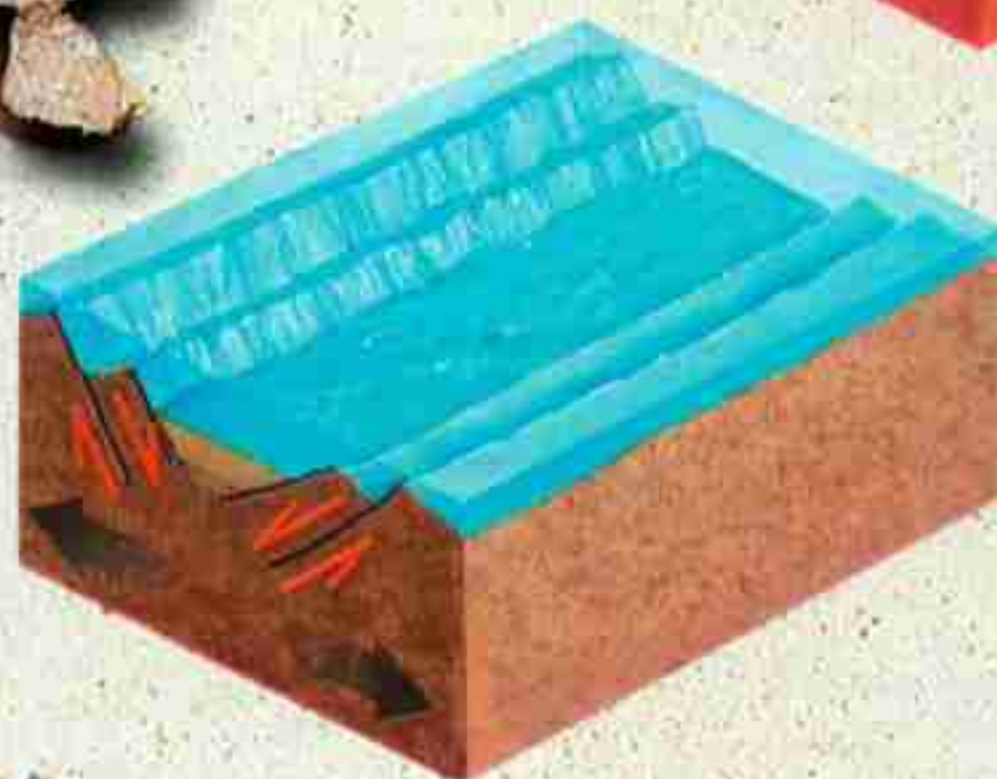
Like the fire-breathing Chimera of Greek mythology—part lion, part goat, part serpent—the area now bounded by Greece and Turkey is a mosaic of incongruous parts that come together fearfully. Trapped between three huge, converging continental plates, the Anatolian and Aegean regions have been roaring and breathing fire for millions of years—and terrorizing humanity for millennia. “It is an exceptional place: You have extreme geologic activity—with frequent earthquakes and volcanic eruptions—in one of the cradles of Western civilization,” says earthquake geologist James Dolan.



Subduction



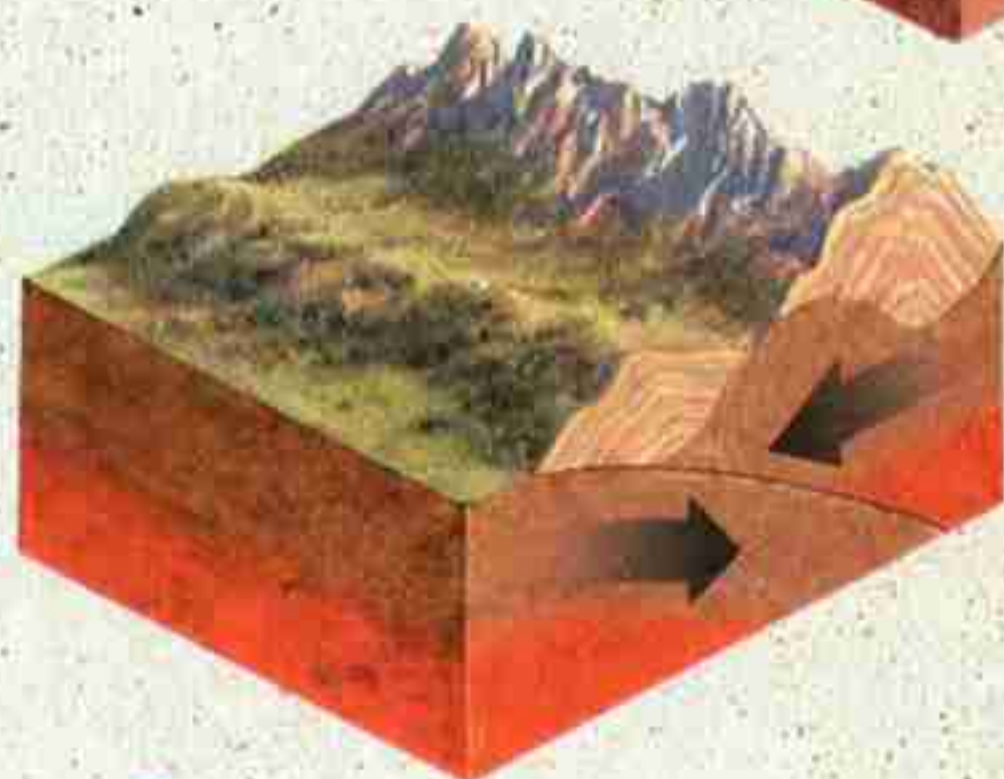
Where oceanic plates meet continental plates, the denser ocean plate pushes beneath the continental plate, and magma rises to create volcanoes.



Extension



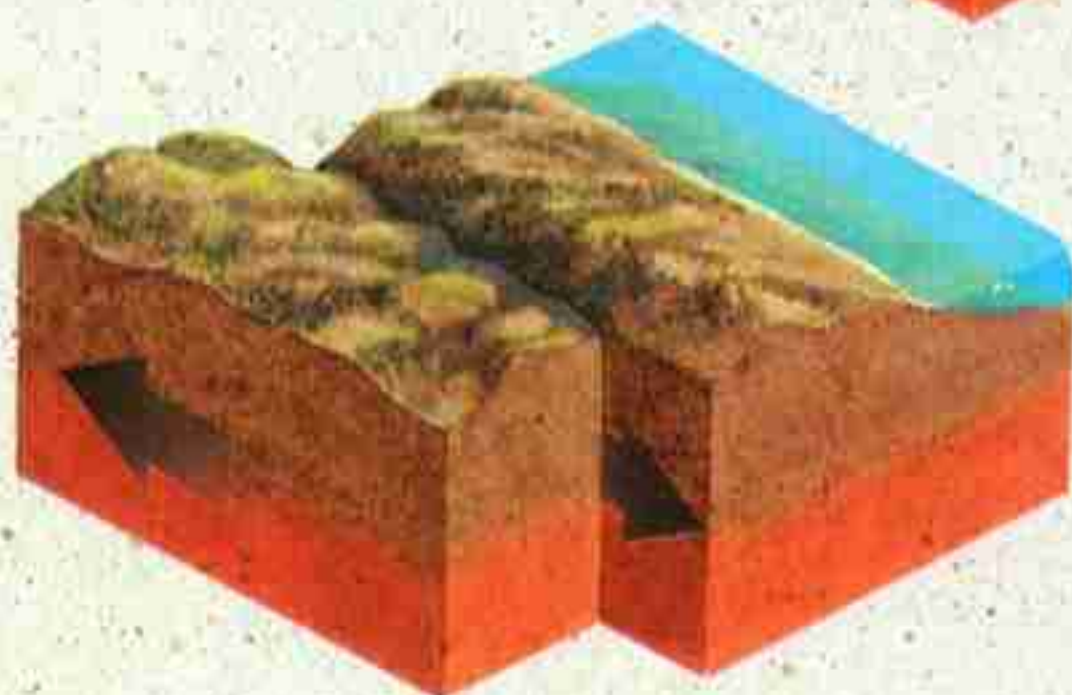
As crust is stretched by subduction, faults can cause it to rise or fall. On land and in the sea, valleys called grabens form and fill with sediment.



Collision



When two continental plates collide head-on, they may push crust upward, forming mountain ranges. Such a collision formed eastern Turkey's mountains.



Strike-slip fault



Plates moving past each other horizontally lock together until tension builds to a release point—an earthquake. Quakes range from barely detectable to cataclysmic.



VOLCANOES AND EARTHQUAKES IN HISTORY AND MYTH

We have known about plate tectonics for only about 40 years. Before that our imaginations—scientific or otherwise—had to make sense of the Earth's geologic forces. Like countless cultures, the ancient Greeks and Romans personified the power of natural forces in a pantheon of gods. Hephaestus (illustration below)—whom the Romans called Vulcan, the namesake of volcanism—was the god of fire and volcanoes, Poseidon the god of earthquakes as well as the sea.

MOUNT OLYMPUS

Greece's highest mountain was the mythical home of Zeus and the palace of the gods.

Mt. Olympus
9,570 ft
2,917 m

CLASHING ROCKS

After epic hero Jason eluded the Bosphorus strait's notorious Clashing Rocks, the rocks fixed themselves to land. The strait remains a treacherous passage.

MOUNT ARARAT

A dormant volcano became the scene of life's second genesis, according to the biblical account that Noah's ark came to rest "upon the mountains of Ararat."

Mt. Ararat
16,854 ft 5,137 m

TROY

Legend has it that Poseidon sent a sea monster to destroy Homer's Troy. It's likely that earthquakes actually did the job.

THERA

About 1600 B.C. one of history's strongest volcanic blasts all but annihilated this Aegean island, contributing to the decline of Minoan civilization.

COLOSSUS OF RHODES

One of seven wonders of the ancient world, a hundred-foot bronze statue was toppled by earthquake in more than 50 years after its completion in the third century B.C.

ANTIOCH

A center of early Christianity, Antioch lost as many as 300,000 people to an earthquake in A.D. 526 and was hit with numerous large quakes between 1097 and 1169, during the time of the Crusades.



IT'S ANATOLIA'S FAULT, BUT ARABIA AND AFRICA ARE TO BLAME

Imagine the Anatolian plate as a slippery seed between a finger and a thumb—the Eurasian and Arabian plates. As the Arabian plate moves northward into the Eurasian plate, it squeezes the Anatolian plate westward, causing earthquakes along the North Anatolian Fault. Farther west, the African plate is pushing beneath the Anatolian plate, stretching the Aegean Sea's underlying crust and allowing magma to rise to the surface through volcanoes.



A STRAIT'S SHAKEN GLORY

It takes either a sturdy boat or a kilometer of bridge to cross the Bosphorus today, but people may have walked cattle across the Bosphorus—which means “ox ford”—before Mediterranean seawater started spilling through the strait into the Black Sea Basin some 7,500 years ago (see “Black Sea Flood,” page 71). It is possible that an

earthquake caused the rupture that opened the strait. Istanbul, perched on the banks of the Bosphorus, has weathered dozens of major earthquakes in the 1,700 years since Roman Emperor Constantine made it the empire’s new capital. Adding to Constantinople’s glory, in 537 Emperor Justinian inaugurated a domed cathedral then unparalleled—Hagia Sophia, or Holy Wisdom (above, dome at left). “Solomon, I have outdone you!” legend says he declared. It only



KOZAK COLLECTION, EARTHQUAKE ENGINEERING RESEARCH CENTER, UNIVERSITY OF CALIFORNIA, BERKELEY

took 20 years for an earthquake to inflict serious damage. The building still stands, many quakes and repairs later, buttressed along the way for stability (top).

A mid-16th-century woodcut (above) depicts an earthquake's aftermath in Constantinople. Unsettling apparitions in an orderly sky, comets throughout history have embodied cultures' worst fears; this one was taken as an omen of the quake.

ALL THESE CONSTRUCTS OF HUMAN IMAGINATION ARE LACED WITH CRACKS OR TOPPLED ON THEIR SIDES.

up!” says Lars-Eric Möre, pilot of a hot-air balloon that has lifted me and a basketful of sightseers over a vista of mushroom-shaped rocks with doors and windows. Farther on we float above a canyon forested with pinnacles and spires of stone in shades of pink, white, ocher, brown, and gray. Then cliffs with churches carved into them by Byzantine monks. Here humans and the forces of geology have coexisted harmoniously and spiritually.

The volcanic avalanches of Cappadocia were generated, like almost every geologic event in the region, as Africa drew closer to Anatolia. Dense oceanic rock in front of the approaching continent subducted beneath Turkey, and as the water-rich rock dived deeper and mixed with the mantle, it created the particularly gaseous magma that exploded across Cappadocia.

Although geologists believe that epoch of volcanism has ended, the subducting of seafloor continues to the west beneath the Aegean Sea. The diving seafloor there exerts a powerful tug, pulling the Aegean crust toward Africa. That tug has stretched and thinned the Aegean, turning what once was dry land into a drowned continent. It is also opening a space into which Anatolia can move as it's being squeezed by Arabia in the east.

Much of Anatolia's westward movement occurs along a particularly dangerous geologic feature known as the North Anatolian Fault. That fault, which separates Anatolia from the rest of Eurasia, runs east to west just south of the Black Sea. About 75 miles before it reaches the Sea of Marmara, the fault forks into at least two strands. The sea, which reaches depths of more than 4,000 feet, is actually a rift, pulled apart by tension between the strands, which continue westward across the Aegean to Greece.

In the Marmara area the North Anatolian Fault has caused immeasurable devastation. In the past 2,000 years almost 600 documented earthquakes—40 of them magnitude 7 or

greater—have hammered the region. İzmit has been destroyed repeatedly, and Istanbul itself has been severely damaged four times by great earthquakes in the past 500 years.

The fault may also have triggered the most catastrophic event ever seen along the Sea of Marmara—an enormous flood about 7,500 years ago that filled up the Black Sea Basin—accord-

ing to Bill Ryan and Walter Pitman, geologists at Columbia University. They recently demonstrated that at the end of the Ice Age the Black Sea was much lower and smaller. Then as glaciers melted, rising seas cut a channel—today's Bosphorus—from the Sea of Marmara toward the Black Sea Basin. Perhaps triggered by an earthquake, an enormous flume of water poured down an escarpment north of modern Istanbul for more than a hundred days, filling the basin to sea level. The flood must have driven settlers all along the former coast from their villages. Perhaps, Ryan and Pitman suggest, it was this sequence of events that inspired the story of Noah's Flood.

ON A RAINY, blustery day I head up the Bosphorus to visit the spot where the fabled strait widens into the Black Sea—the presumed site of the breakthrough. The waters of the strait grow rough where the Mediterranean once cascaded. I watch waves toss fishing boats bringing in their hauls of mackerel, bluefish, and bonito—and the angry waters still seem to echo the prehistoric turmoil of the flood. No wonder the ancients feared this passage. In Greek mythology the headlands on either side of the Bosphorus were great rocks that crashed continually against each other, preventing ships from sailing through to the Black Sea. Not until courageous Jason and the Argonauts passed safely through did the rocks cease their clashing forever.

The North Anatolian Fault played a role in the formation of another Turkish strait, the 38-mile-long Dardanelles, which connects the Sea of Marmara with the Aegean. I drive along the Gallipoli Peninsula, watching the ships of many nations steam toward old Byzantium in the late afternoon sun. Few places evoke such human history. Here in 480 B.C. the Persian King Xerxes built a bridge of boats to stage an

abortive invasion of ancient Greece. Alexander the Great crossed back over in 334 B.C. en route to conquering the world. Attempts to control the Dardanelles sparked desperate battles between the Turks and Allies in World War I.

Myth touches the Dardanelles too—in a tale of ancient Troy, which guarded the entrance to the Dardanelles throughout the Bronze Age. In Homer's *Odyssey*, the Greek hero Odysseus devised a trick that ended the Trojan War. Greek soldiers hid within a great wooden horse, which the Trojans unsuspectingly took within their city walls. I stand in front of one of those walls with Manfred Korfmann, an archaeologist at the University of Tübingen. Korfmann explains another theory about the Trojan horse.

"See those cracks?" says Korfmann, pointing to the heavy gray stones of the tower. "Most people regard them as earthquake cracks." Korfmann suspects that over several centuries the Greeks fought many skirmishes with Troy because Troy controlled access to sources of metal around the Black Sea. He believes that at some point an earthquake may have brought down Troy's walls, letting the Greeks in. To celebrate their victory, the

Greeks may well have erected a horse to thank Poseidon for the quake—the horse being a symbol of Poseidon.

Two particularly devastating earthquakes around A.D. 500 demolished Troy once and for all. In fact, an unparalleled wave of big earthquakes from the mid-fourth to the mid-sixth centuries hit all the major cities of southwestern Turkey: Pergamum, Aphrodisias, Ephesus, Smyrna. This puzzling sequence, called the early Byzantine tectonic paroxysm, may reflect a huge shifting of plates from Palestine to Crete. "It was not a good time to be alive," says Brian Rose, an archaeologist at the University of Cincinnati. "The earthquakes kept coming."

The force that gives rise to most of the earthquakes that plague the Aegean region of Turkey is called extension. As the subducting African plate stretches and thins the crust, great cracks known as grabens open up. The grabens become valleys that fill with fertile sediments.

Extension in the Aegean has enriched the

SWIMMERS STRADDLE fluted columns in a geothermal pool near the ancient Roman city of Hierapolis. Geology giveth—Romans flocked here to bathe—and geology taketh away: The city was destroyed by repeated earthquakes. Floating among the ruins, tourists revel in the paradox.



Image Not Available

SAVED BY A VOLCANO: This ancient fresco was preserved by the same eruption that destroyed the home of its creators. Buried under two stories of pumice, ash, and debris 3,600 years ago, the town of Akrotiri on the Greek island of Thera has yielded clues to Minoan and Cycladic culture.

soil of southwestern Turkey. But the same process, occurring too rapidly and accompanied by centuries of deforestation, has encouraged the buildup of too much silt in places, turning waterways into swamps and until recently encouraging the spread of malaria.

With İlhan Kayan, a geographer at Aegean University, I visit the Little Meander Valley south of İzmir. As we look out over the farmland, İlhan explains how heavily the silt has accumulated in some parts of the region: “The sediments are 88 feet deep in the center of this valley,” he says. “If you could take a big vacuum cleaner and suck them all up, the sea would flow in here.”

Both earthquakes and the steady buildup of silt made life difficult for the residents of Ephesus, the best preserved of the ancient cities in the region. İlhan takes me to a hill overlooking the site of the Temple of Artemis, constructed to the goddess of the hunt in the sixth century B.C.

“They probably built that great temple on the coast,” says İlhan. Today I can barely see the Aegean; the encroachment of silt has shifted the shoreline five miles to the west. Being stranded so far inland destroyed the economic viability of Ephesus. That and Christians having no desire to maintain a city filled with pagan monuments. Still, the huge marble temple that once stood below us, built to honor the Greek goddess, was one of humanity’s greatest achievements—and one of the seven wonders of the ancient world.

Image Not Available

Thera Foundation, Piraeus, Greece

A LONG TURKEY'S southern coast the process of extension has caused land on the shore to drop into the Mediterranean. At the town of Üçağız I hire a boat to sail across a bay that once did not exist. "Scientists tell us there is a Roman amphitheater below us," says the captain, İbrahim Turan. We cross to an island named Kekova, once a Byzantine city, that is sinking into the sea. We cruise past the subsiding buildings that line the shore. Beneath the boat lie the foundations of houses.

At the same time Kekova is dropping into the water, land across the Aegean in Greece is rising rapidly. Stathis Stiros, a geologist at the University of Patras, takes me along the south coast of the Gulf of Corinth, a dramatic waterway separating the Greek mainland from the Peloponnesian peninsula. On the eastern shore of the gulf we stand on cut rocks that, around 500 B.C., were laid underwater to build a

harbor at Corinth, a wealthy city renowned for its elegant pottery. Stiros points out holes that were drilled in the rocks by marine animals.

"Those holes were made underwater," he says. "Now they are nearly four feet above the shoreline."

The entire southern coast along the gulf is rising. Stiros takes me farther west to a rocky terrace where corals that lived some 30 feet underwater 10,000 years ago now stand about 20 feet above it. In the mountains that plunge to the coast we wander through the ruins of the city of Aigeira, nearly a thousand feet above sea level. About 120,000 years ago, says Stiros, we'd have been at sea level.

Basically the Gulf of Corinth is a deepening graben. The Peloponnesus was pulled away from the mainland by the same extension forces that stretch western Anatolia and the Aegean. But, more important, the same land is also being squeezed by a familiar culprit.

"All of central Greece is now caught up by the North Anatolian Fault," says Rolando Armijo, a geologist at the Institut de Physique du Globe in Paris. "The northern branch is driving up mountains, including Mount Olympus. The southern branch is arriving about 60 miles to the south. The Gulf of Corinth and Athens are on the front edge. The land around it is cracking as the fault approaches. We call it the damage zone."

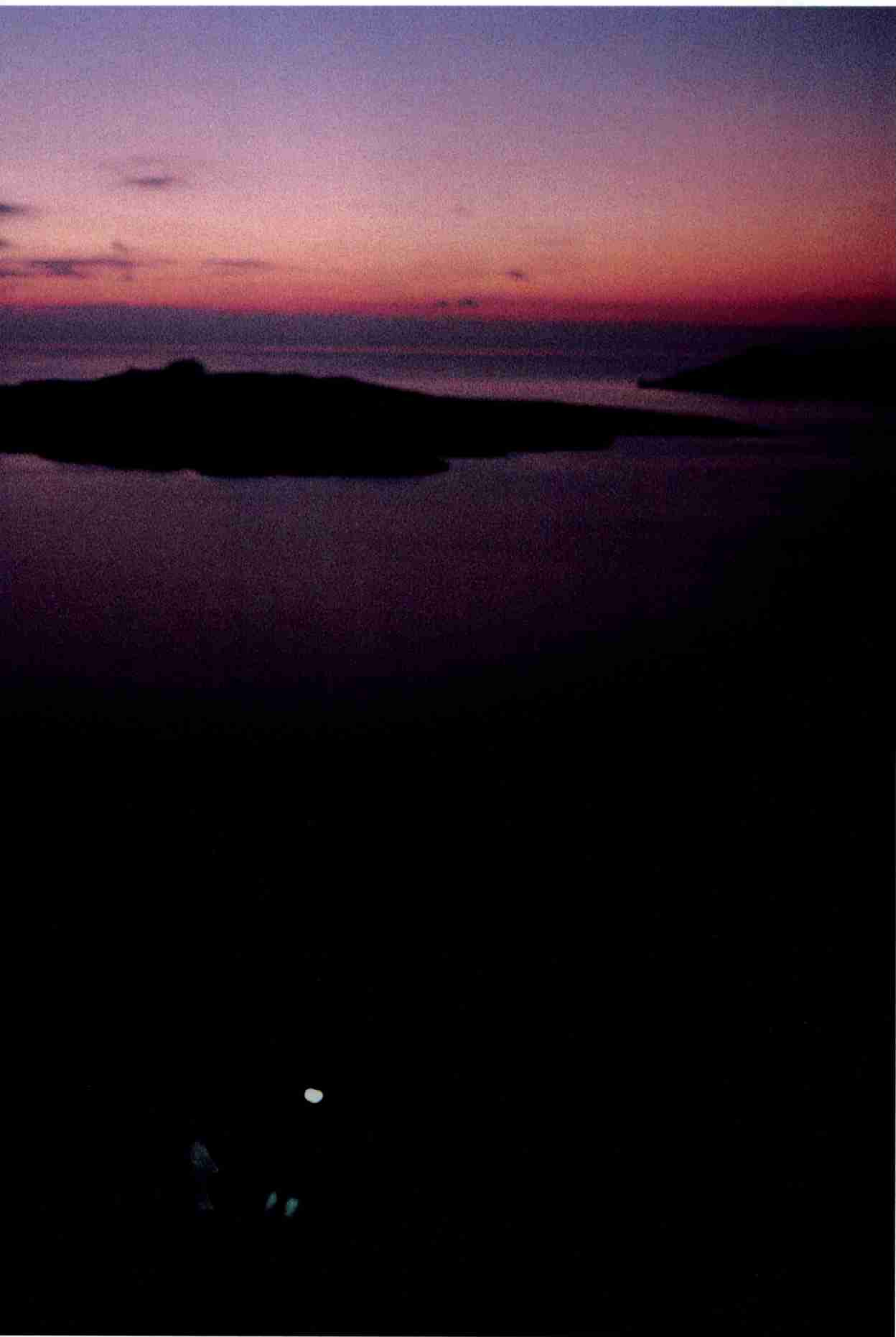
On September 7, 1999, Athenians were surprised to learn they lived in such a place—even though the Parthenon bears cracks from earthquakes in past centuries. On that day a magnitude 5.9 quake shook Athens for 15 seconds, killing 143 people and leaving more than 50,000 homeless.

Earthquakes have struck far more frequently to the southwest of Athens in the Peloponnesus, devastating some of the great cities of ancient Greece. "There's been a lot of bloodshed here," says Iphiyenia Tournavitou, an archaeologist at the citadel of Mycenae. In mythic Greek tragedy these brooding ruins witnessed horrific human catastrophe. Here Clytemnestra murdered Agamemnon for sacrificing their daughter Iphigenia to the gods, and Orestes slew his mother for killing his father.

From this strategic palace on top of a steep hill, the elite families of Mycenae became one of the great powers of the Greek world in the 14th and 13th centuries B.C. Yet the walls of



THE GODDESS APHRODITE flanks the handiwork of her sometime lover Hephaestus, god of volcanoes. In a blast 90 times that of Mount St. Helens, the center of Thera collapsed into a sea-filled caldera, where a new cone slowly builds. Some call this the source of Plato's story of the lost continent Atlantis.



their citadel, it turned out, were as vulnerable to forces in the Earth as its rulers were to human passions.

Mycenae, like all the great citadels of the region, has suffered many earthquakes over time. "In 1250 B.C. the city experienced major destruction," says Tournavitou. "We find people crushed beneath the walls of their houses." But the citadel was quickly rebuilt and extended. Fifty years later a bigger disaster hit Mycenae. "They never quite recovered. The ruling aristocracy must have collapsed."

Invading raiders disrupting trade in the Mediterranean probably undermined the Mycenaean economy. But increasingly archaeologists see earthquakes as opening the doors to destruction, much as they might have knocked down the walls of Troy, letting in the Greeks. Most agree that earthquakes, and especially a titanic volcanic eruption around 1600 B.C. on the island of Thera, led to the decline of the powerful Minoan culture on the nearby island of Crete.

Floyd McCoy and Grant Heiken, scientists financed by grants from the National Geographic Society, have studied the Thera eruption—one of the largest in history. A smaller first eruption, which put down a dusting of ash before the main event, may have scared most of the people away—excavations have revealed no skeletons.

The second eruption began with a blanket of light pumice that buried the town of Akrotiri, downslope, many feet deep. Then seawater entered the vent of the collapsing volcano and explosively mixed with magma and gases. The enormous amount of steam generated by the water made an already violent eruption ultra-explosive, McCoy explains, "the worst kind of eruption we can get on this planet."

Thera's ash and pumice snowed down on Crete, 70 miles to the south. Tsunamis battered its north coast, perhaps sinking many Minoan ships—disaster for a seafaring culture. The ash likely destroyed crops along with the grasses that fed livestock.

This was not the first geologic catastrophe on Crete. "At least a century earlier a great earthquake destroyed the palace at Knossos, the center of Minoan power," says Eleni Hatzaki, curator at Knossos for the British School at Athens. "The Minoans rebuilt on a grand scale, and the peak of their culture followed."

But another major quake seriously damaged the palace around the same time as the eruption on Thera. In the decades that followed, all the major palaces on Crete were destroyed by fire—probably set by invaders—and eventually Mycenaean Greeks took control of the island.

Earthquakes continue to ravage Crete as Africa, only 200 miles to the south, approaches. As the eastern part of the island sinks, the western part is rising dramatically. Dating the shells of marine animals that live at sea level, geographer Paolo Pirazzoli of the French Research Council finds evidence for an astounding uplift of 27 feet in one great earthquake. He thinks it occurred on July 21, A.D. 365, the date of a huge Mediterranean tsunami.

On the far west coast of Crete that incredible upthrust pushed a Hellenistic harbor named Falasarna about 20 feet above sea level. On the last day of my journey I climb the mountain behind the town. Its slope is littered with blocks cut from nearby cliffs and hauled here long ago to build foundations. The climb is strenuous, and I grow sad. So much energy went into this town, now nothing but ruins.

A blast of wind nearly knocks me off my feet. I imagine myself lashed by Poseidon's breath. No. I'm just exhausted by this journey and feeling small and powerless in the face of all the forces the earth shaker represents. I remember what I saw after the İzmit earthquake and wonder why so many people had to die. Are all our labors futile?

Another gust, and I remember Adapazarı, near the epicenter of the İzmit earthquake—I visited there three months after so much of it had collapsed. New buildings were already going up. The muddy streets throbbed with life. Even though many residents were living in tents, energy was returning. A sticker on the back window of a car read: "I love my Adapazarı and I'm not deserting it."

On that windswept mountain it occurs to me that humans are not so powerless after all. We are durable. We possess the cleverness of Odysseus, the sublimeness of Homer, even the vanity of Antiochus. We are fired by the forces of imagination and love and by the ability to cry over our tragedies and, above all, to envision a new day. That's what keeps us even with the earth shaker. We bounce back—and cloak the worst that nature can do to us with the grace of our humanity. □

BLACK SEA FLOOD

NEW EVIDENCE OF CATAclysmic CHANGE

Once upon a time, when people wanted to find evidence of the biblical Flood, they searched the flanks of Mount Ararat for remnants of Noah's ark. Now scientists are finding mounting evidence that there may have been a calamitous flood of the Black Sea about 7,500 years ago—close enough to historical times to give rise to an ancient flood myth.

As the last ice age was waning 12,000 years ago, the Black Sea was a smaller, freshwater lake. As glaciers melted over the following millennia, global sea levels rose gradually but markedly; it was thought that the Black



Sea's level did likewise. Now it appears that a natural dam at today's Bosphorus may have held the rising Sea of Marmara at bay—until the dam's collapse sent ten cubic miles of seawater a day roaring into the Black Sea, then 500 feet lower. The sea would have pushed inland up to a mile each day for months, forcing inhabitants to flee. This is the theory of marine geologists William Ryan and Walter Pitman, who in 1993 found a sediment and marine-life record off the sea's north shore suggesting such a flood. Corroborating that theory, last summer

ocean explorer Bob Ballard found a beach beneath 500 feet of water near the sea's south shore. The sediments yielded lakeshore rocks and shells—freshwater shells as young as 7,800 years old and saltwater shells as old as 7,300 years—indicating the freshwater lake had been inundated by salt water. Buoyed by the find, Ballard plans to search for evidence of human settlement along the drowned shore.

For more about Bob Ballard's exploration go to www.nationalgeographic.com/blacksea.

RESEARCH PROJECT

Supported in part by your Society

BY DOUGLAS H. CHADWICK

PHOTOGRAPHS BY RANDY OLSON

THE SAM

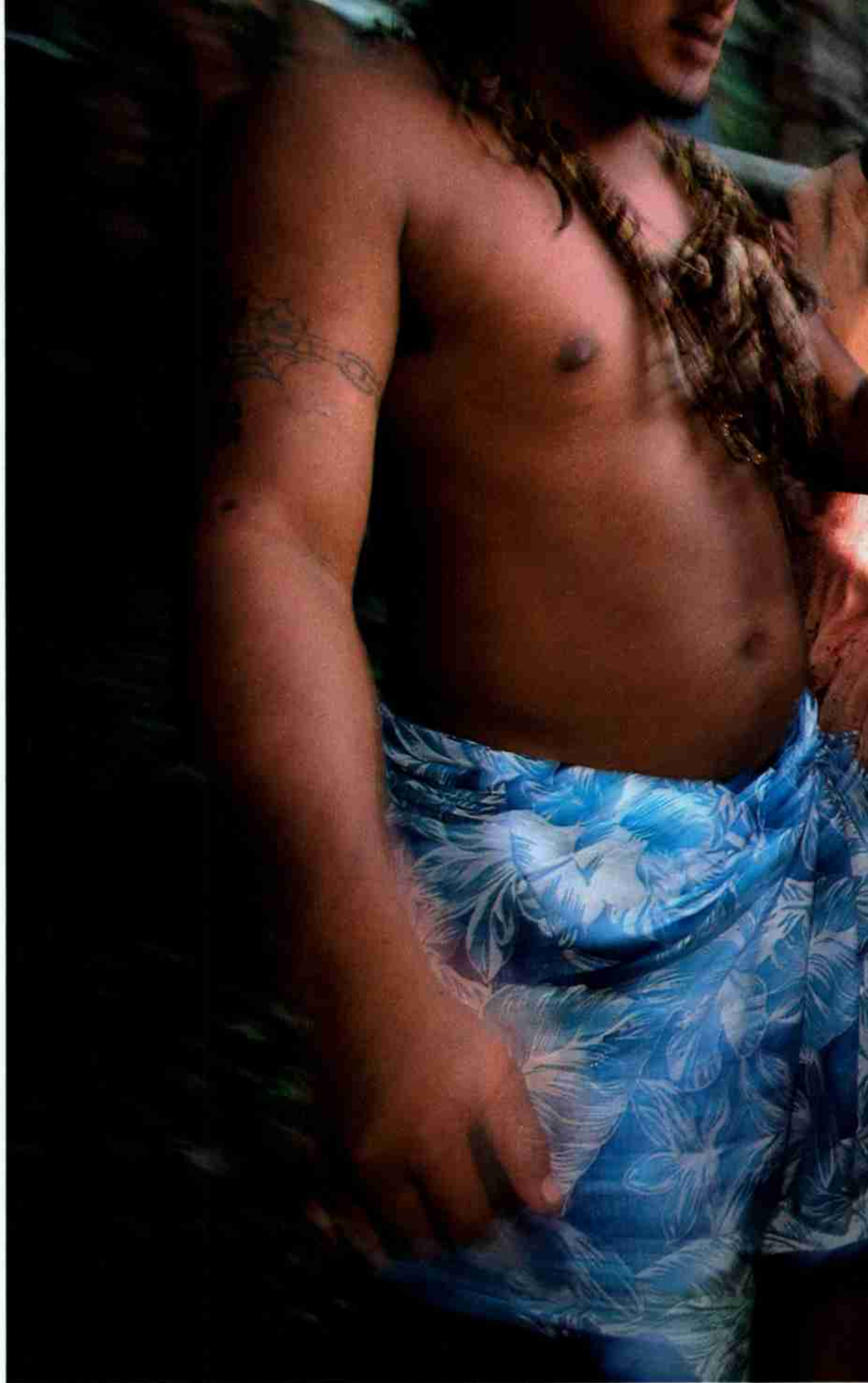
A NEW U.S.
NATIONAL PARK
PRESERVES A
PRISTINE
TROPICAL
ECOSYSTEM.



O A N W A Y

*Shopping for dinner, a diver
hunts clams and sea urchins
off Ofu Island, whose coral
reef lies within the park's
10,500 acres. Only residents
may fish this sanctuary in
American Samoa, the first
U.S. national park in
the Southern Hemisphere.*

Dressed out for the occasion, a wedding gift is toted to a reception on Tutuila Island. An occasion at which extravagant gift giving is expected is referred to as fa'alavelave, a term that can mean "generosity," "obligation," or "troublesome."



A THIRD OF OUR PLANET IS PACIFIC OCEAN. Away out in that undulating blueness, 2,600 miles southwest of Hawaii and 1,800 miles northeast of New Zealand, appears the small island known as Ofu. Built of soaring black stone, it is robed in rain forest and further softened by summit mists from which waterfalls spill back down toward the sea.

I lie floating a few feet from shore, fingertips lightly anchored



in sand. Inches from the bottom half of my diving mask, long-nose filefish cruise over coral colonies.

I keep the top half of my mask above the water, watching raindrops pock the surface. Beyond, palm fronds sweep over a white beach where Ofu tapers toward the storm-blue spires of its sister isle, Olosega. There is nobody on the shore, only fat coconut crabs clawing their way into fallen coconuts to gorge

on the sweet coatings inside. I could stay like this for hours—and do, in one of the newest, most unusual, and least familiar additions to the U.S. National Park System, the National Park of American Samoa. The entrance signs, in Samoan, read *Paka o Amerika Samoa* with the subtitle *Laufanua Fa'asaoina*, or preserved land.

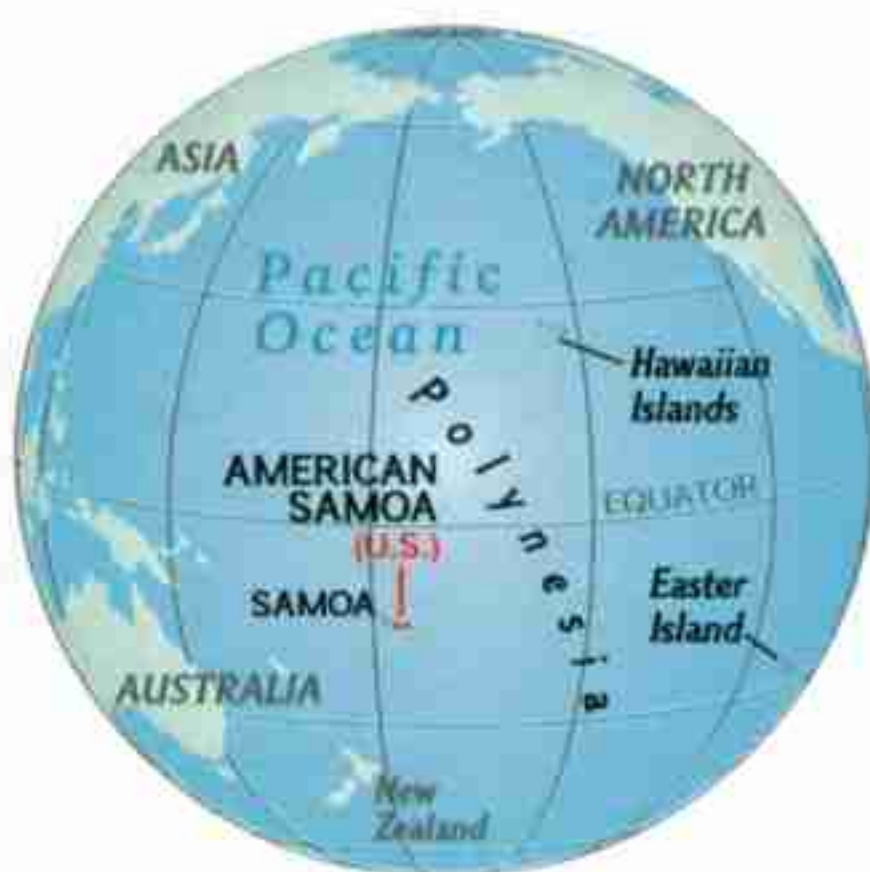
SAMOA ITSELF is said to mean “sacred center.” It is an archipelago strung along an east-west axis roughly 14 degrees south of the Equator. According to geologists the coral-fringed islands are the tops of volcanoes that rose from the seafloor, hissing and streaming lava as crustal plates shifted below. An older story is that this is where the world began as the creator, Tagaloalagi, first called forth earth, sea, and sky from rock. Then, the Samoan legend continues, he made the first human being.

Anthropologists also view the Samoan islands in terms of origins. Language links and artifacts suggest that the first distinctly Polynesian culture may have developed here some 3,000 years ago. Over the centuries that followed, seafarers in double-hulled sailing vessels stocked with pigs, dogs, and fruits spread that culture across much of the Pacific, colonizing points as distant as Hawaii, New Zealand, and Easter Island.

During the modern colonial era the western end of the Samoan chain fell under Germany's control, then New Zealand's. In 1962 it became the independent nation of Western Samoa, now known simply as Samoa. The U.S. took possession of the eastern half of the archipelago in 1900. Its largest island is Tutuila, where the Navy maintained a base at Pago Pago harbor until 1951. Sixty miles east rise Ofu, Olosega, and Ta'ū, the islands collectively known as Manu'a, revered in legend as the birthplace of Polynesia and long a powerful kingdom in its own right.

Together with another small island and two coral atolls, Tutuila and the Manu'a group make up the U.S. Territory of American Samoa, current population about 64,000. Overseen by the Department of the Interior, the territory has its own legislature, an elected governor, and a nonvoting representative to Congress. Today it also has a 10,500-acre national park, a quarter of which extends from the beaches out to sea.

The United States' only parkland in the Southern Hemisphere was created to protect three kinds of communities under pressure from modern forces. First is the paleotropical rain forest, where the flora and fauna stem mainly from Southeast Asia, forming habitats unique within the U.S. park system. Second is the Indo-Pacific coral reef, markedly richer in species than reefs in other ocean regions. Third, bound to both rain forest and reef, is the indigenous Polynesian culture. The crafts,



Scale varies in this perspective.
60 miles from
Tutuila to Manu'a
NATIONAL GEOGRAPHIC MAPS
RELIEF BY JOHN BONNER



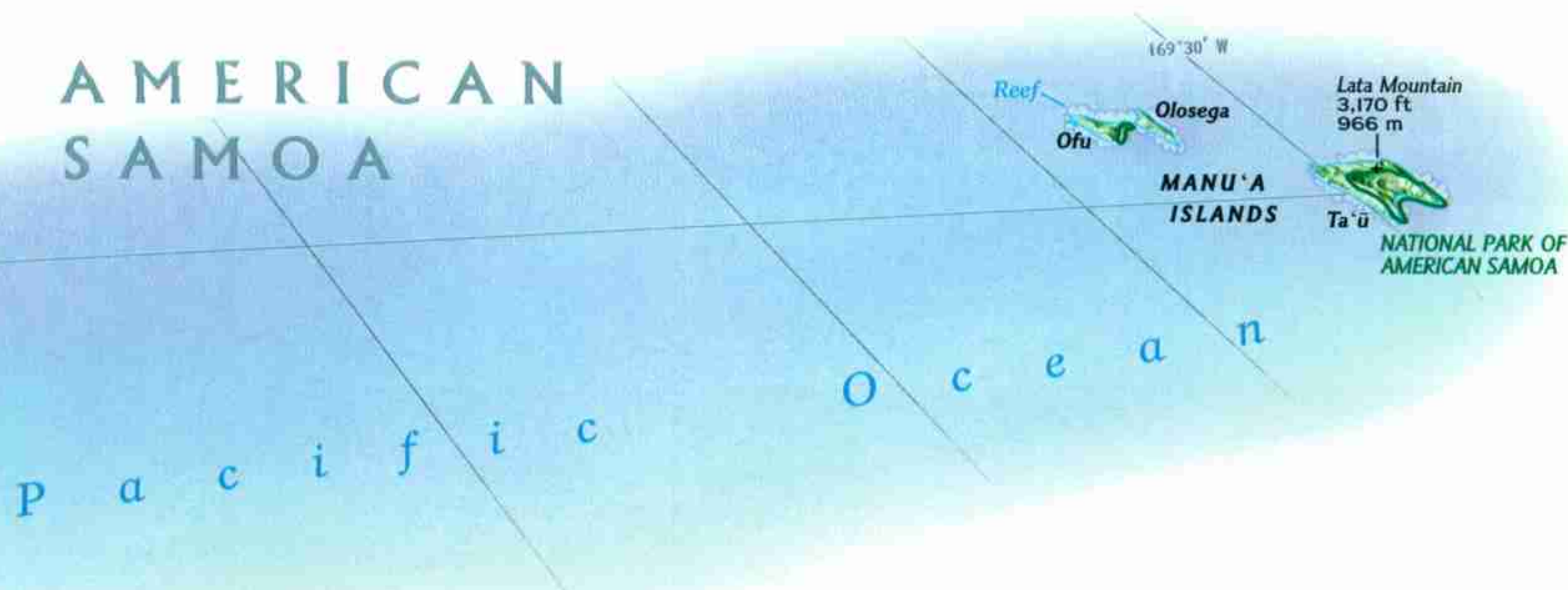


customs, and knowledge that define *fa'aSāmoa*, the Samoan way, are among this park's most valuable living resources.

Authorized in 1988, Paka o Amerika Samoa is still very much a work in progress. It wasn't officially dedicated until 1997 and probably sees fewer than 500 tourists from outside the islands in the course of a year. Although a modest headquarters and visitor center have opened at Pago Pago, the territorial capital, there are no patrol rangers, entrance stations, or trails yet, just a tiny staff at work on a vast store of possibilities.

Ta'ū is formed by the tallest peak in American Samoa, 3,170-foot Lata Mountain. The clouds that almost perpetually shroud the volcano's heights may loose as much as 300 inches of rain yearly, while the sunlit lower slopes steam in greenhouse profusion. Sweating his way uphill, Chris Stein, the park superintendent (soon to take a new park position stateside), whispers, "We'll probably put a trail into this area

Rain forest blankets the volcanic islands of this U.S. territory (map). The park aims at protecting coral reefs, Samoan culture, and rain forest flora and fauna, including the flying fox bat (above), whose wingspan reaches three feet.



but maybe not right here. You can see why.” Before us gapes a side crater whose whole interior is aswirl with chittering mammals aloft on three-foot wingspans. Despite our efforts to sneak up undetected, we have disrupted the daytime roost of fruit bats known as white-necked flying foxes.

A more elusive fruit bat, the Samoan flying fox, is normally active during the day, soaring over the forest canopy like a hawk. Folktales cast these animals as guardians of the forest. Ecologically, they fill that role. The only land-dwelling mammals other than the sheath-tailed bat to occur naturally in Samoa, they help maintain the woodlands by pollinating and distributing the seeds of a large proportion of the islands’ vegetation.

Hunters with modern weapons put heavy pressure on the big bats. Habitat loss made matters worse in neighboring Samoa. Nearly two-thirds of the original forests there have been cut for timber and cleared for agriculture. Then a series of hurricanes beat down the depleted populations of white-necked and Samoan flying foxes to perilously low levels. The desire to save these two important species—together with the islands’ native vegetation—was a major factor in the push for a national park.

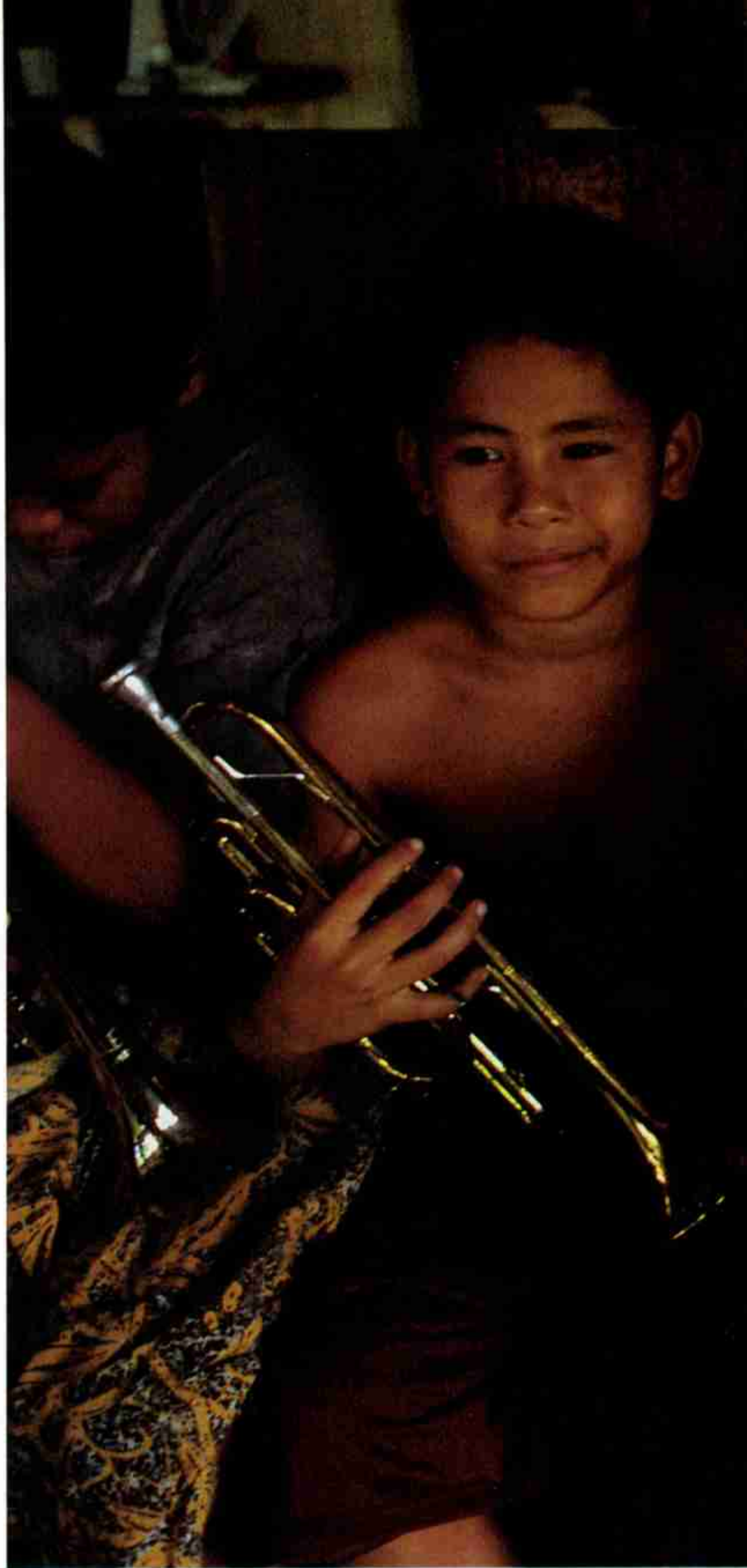
STEIN AND I hike on to a larger side crater. As we descend into the sunken valley, tendrils of mist from Lata’s summit come coiling down our way. Cries of white-tailed tropicbirds echo strangely off the sheer sidewalls. Deeper yet, the air stills, and the place takes on the feel of a world apart. Vines close around us. Thirty-foot-tall tree ferns claim the light overhead.

“This,” Stein announces into the hot gloom, “is where we keep our tyrannosaurs.”

Joking of course. Not counting marine types, like the footlocker-size sea turtle I watched graze on algae in a bay, the only reptiles around are skinks and geckos. And snakes. Ta’ū, alone among the islands, has a few, including the native Pacific boa. Meanwhile, big freshwater eels have been seen slithering across rainy woodlands far from the nearest stream, sometimes carrying captured rats in their jaws. It does begin to make you wonder what else waits behind the next thicket.

Although the park may be small by continental standards, its marine segments run along almost 15 percent of American Samoa’s coastline,

Since 1977 DOUGLAS CHADWICK’s work for NATIONAL GEOGRAPHIC has taken him from Arctic wilderness to the coral reefs of the Philippines. RANDY OLSON’s last assignment for the magazine was “Indus Civilization,” in the June 2000 issue.

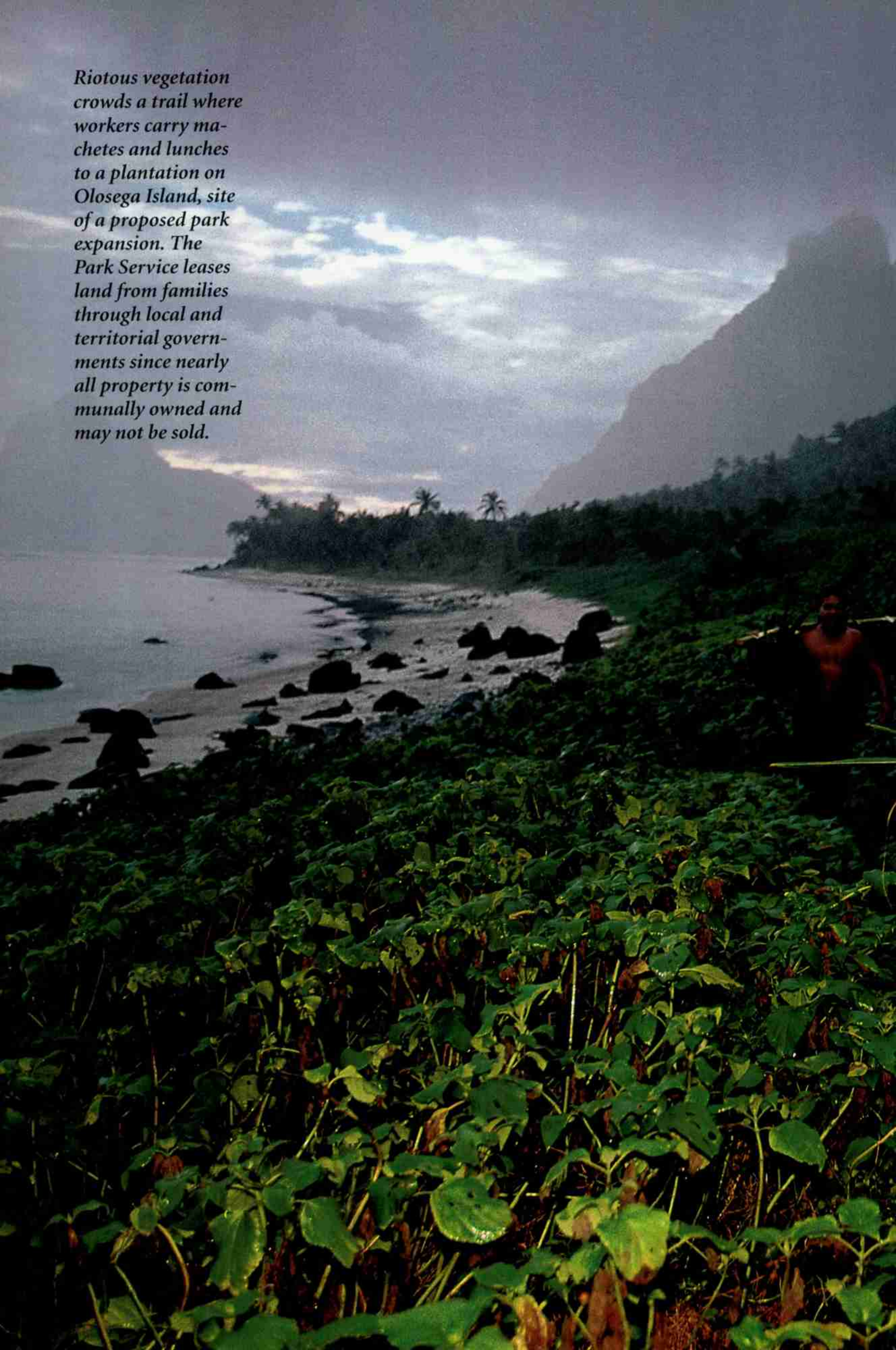


Budding musicians learn from their father, Fiatamali’i Leuta, who wears the traditional lavalava wrap. Leuta heads a church band that plays modern tunes at social events. Vocal and instrumental ability is highly prized in this society, bound by a strong oral tradition.



NOBODY SINGS ABOUT
PARADISE AS BEAUTIFULLY AS THESE
PEOPLE ALREADY LIVING IN ONE.

*Riotous vegetation
crowds a trail where
workers carry ma-
chetes and lunches
to a plantation on
Olosega Island, site
of a proposed park
expansion. The
Park Service leases
land from families
through local and
territorial govern-
ments since nearly
all property is com-
munally owned and
may not be sold.*







while the land pieces add up to more than 16 percent of the territory's total land area of 77 square miles, a larger proportion than national parks cover in any U.S. state.

How can this be when virtually no federally owned acreage exists in American Samoa? The islands for the most part are the communal property of extended Samoan families and by law cannot be transferred or sold to outsiders. The territorial government has jurisdiction over the nearshore waters. Forced to get creative, the Park Service leased the marine areas and several small land parcels from the territory, then proceeded to lease the bulk of the park's land from eight different villages.

“**O**UR MEETING IS AS SACRED as the tips of two clouds passing in the sky. Our meeting is as the joining of sea turtles, silent, motionless, and sacred. Our meeting is as sacred as the first dew. . . .” Not having mastered the Samoan language, I can't tell if this is exactly what is being said. But I know that such phrases are favored in formal Samoan speech, which is an art in itself. And in the village of Vatia on Tutuila's north shore, we are beginning one of the most formal occasions of all, an *'ava* ceremony.

Every village has its own orator, a high-talking chief. The words of this one braid together long, shining strands of family ancestry and spiritual forces. He also speaks of everyday affairs on behalf of the high



Welcoming glow at twilight bathes a combination social center and meeting-house in the village of Sa'ilele.

When dry, pandanus leaves (right) will be made into mats for sitting and sleeping. Fine mats of narrow, tightly woven strips are given as gifts and used as currency in this legendary birthplace of Polynesian culture.

chief. Wearing little but traditional tattoos and the skirt-like wraps known as lavalavas, these and other ranking men sit at one end of a big oval house open to the bay on one side, to towering emerald slopes on the other, to a wind carrying scents of salt mixed with blossoms. I sit in my lavalava at the opposite end next to Chris Stein and Leota Vaea AINU'u, then the park's chief (and only) ranger and a high-talking chief himself, by wooden posts reserved for honored guests.

According to legend the original 'ava ceremony took place between the first man and the creator, who prepared a drink from roots of the kava, a type of pepper plant. Offering this astringent, brown, slightly numbing beverage has been a symbol of welcome and communion ever since. While the untitled men of Vatia prepare a feast outside, a ceremonial virgin in feathered headdress squeezes juice from the kava root into a carved bowl. A man serves the result to me in a sweeping flourish accompanied by a warrior's whoop.

I hold the bowl up in thanks and then drain it in one draught. Noble words flow along with gifts of cloth and fine, woven mats. Next come banana-leaf platters of suckling pig, fish, breadfruit, papaya, taro root, baked coconut cream, all in portions too generous to finish.

"What God has given us, we are happy to share with others," proclaims Tuiasosopo, the orator. He isn't referring to the bounty dripping from our chins though. He means the lands and waters that have become the park.

People who have land within this contractual park not only get to divide up annual lease payments but also may continue to gather wild foods and other natural materials from the woods and waters. Subsistence farming is also allowed as long as it's limited to land that's been farmed in the past. Noncommercial fishing is OK, as is the construction of traditional shelters for farmers. From 1993, when the final wording was agreed upon, the lease contract runs for 50 years and is subject to renewal by mutual consent. In the meantime any family that grows dissatisfied with the arrangement may withdraw its land from the park with a year's notice.

This arrangement is something of a gamble, given that parks are supposed to safeguard certain values in perpetuity. Concerned that a year could be too short a time for working out problems that might arise with leases, one senior Park Service planner describes the new park as







“slippery.” On the positive side, Paka o Amerika Samoa expands the concept of parklands—and the possibilities for making more of them. It could prove to be a model for conserving nature hand in hand with a thriving culture.

WHEN I LEAVE Vatia village to explore the park near Mount ‘Alava, the heavens pour rain thick as drapery. The steep, machete-cut path down Levaga Ridge turns to goo. Never have I sunk so far in status so fast, from feasted dignitary to bedraggled butt slider with one hand clawing mud and the other flailing for branches to grab. Yet the air is warm as ever, and I take comfort knowing that this kind of wet built the surrounding forest of trees heavysset with orchids and twisting lianas. Wild ginger blossoms burn orange in the understory. Samoans use gel-like sap from the buds as shampoo. Since I’m already showering, I go ahead and soap my head.

Siaifoi Fa’aumu of the territory’s Department of Marine and Wildlife Resources points out a bird’s nest fern, one of 230 species of ferns and their close relatives found on the Samoan islands. In the center of its broad leaves is a young brown booby, looking as if it had sprouted right there. A step beyond, the ridge falls away at a sheer cliff. I can see boobies, frigatebirds, and fairy terns riding the sea winds back from fishing sites while waves break a hundred feet straight down past my feet.

Here on the island’s steep slopes the rain forest structure has remained largely intact—spared the logging and intensive agriculture that, in Samoa and other South Pacific islands with more accessible terrain, have shed silt and agrochemicals onto coral reefs offshore.

The reef in the park along Ofu is a filigreed labyrinth of at least 64 different varieties of corals, from azure-tinged mushrooms to char-treuse vases. Boulder corals hundreds of years old bulge big as whales. I free-dive the underwater channels between them, gawking at unicorn-fish, a banded snake eel, green sea turtles. Gradually the reef reveals itself to be a collection of highly organized neighborhoods.

One type of staghorn coral resembles stalagmites rising from a tabletop. Minnow-size damselfish school around the coral structure like haze. When alarmed, they withdraw in a flash to crowd among the stalagmites, turning them a quivering black and blue.

Napping after church, these teenagers have grown up in what to outsiders seems like paradise, but American Samoa is not the Eden of free love it was once believed to be. Nineteenth-century missionaries found that local mores meshed with their own, and Christian churches like Sa‘ilele’s Congregational parish (above) have multiplied.



Wandering the beach the next day, I encounter Mafuta Tili Vo'a, a woman who collects wild plants for the practice of *fofō*, Samoa's traditional art of healing. Her mother, a midwife, taught her the use of herbs and ways to exorcise troublesome spirits. Now middle-aged, Mafuta is passing on the knowledge to her own children. "Sometimes nurses send patients from the clinic over to me," she says. "It isn't enough just to know the plant medicines. You also have to feel God working through you. If you don't pray, you can't have a good *fofō*."

Mafuta embodies American Samoa's fusion of Polynesian traditions and Christian teachings. Missionaries reached the islands more than a century ago, and churches have since come to play such a prominent role in village life that the territory has been called the Bible Belt of the South Seas. This is at odds with the region's reputation for being short on clothing and inhibitions, an image woven from lusty sailors' tales and later reinforced by Margaret Mead's widely read book *Coming of Age in Samoa*, which dealt with adolescent sexuality.

Many a traveler is taken aback to find that it is considered offensive here for women to wear shorts or skimpy tops, much less bathing suits. And one mustn't swim or indulge in any other form of recreation near villages on Sundays, set aside for family visits, feasting, and worship.

Judging from the services I attend, nobody sings about Paradise quite as beautifully as these people already living in one. And every weekday



Outfielders in a pickup game play deep on a landing strip on Ofu Island, used for only two flights a day.

Workers end their shift at a tuna cannery on Tutuila (right). Furnishing more than 30 percent of the U.S. mainland's tuna imports, canneries employ a third of the territory's workforce. The government employs another third.

closes with *sā*, 15 minutes or so of prayer and reflection led by family elders. A bell tolls, and the village hushes until the only sounds are murmured vespers from the open-air houses and the trilling of birds as the last light works its way up toward the crags.

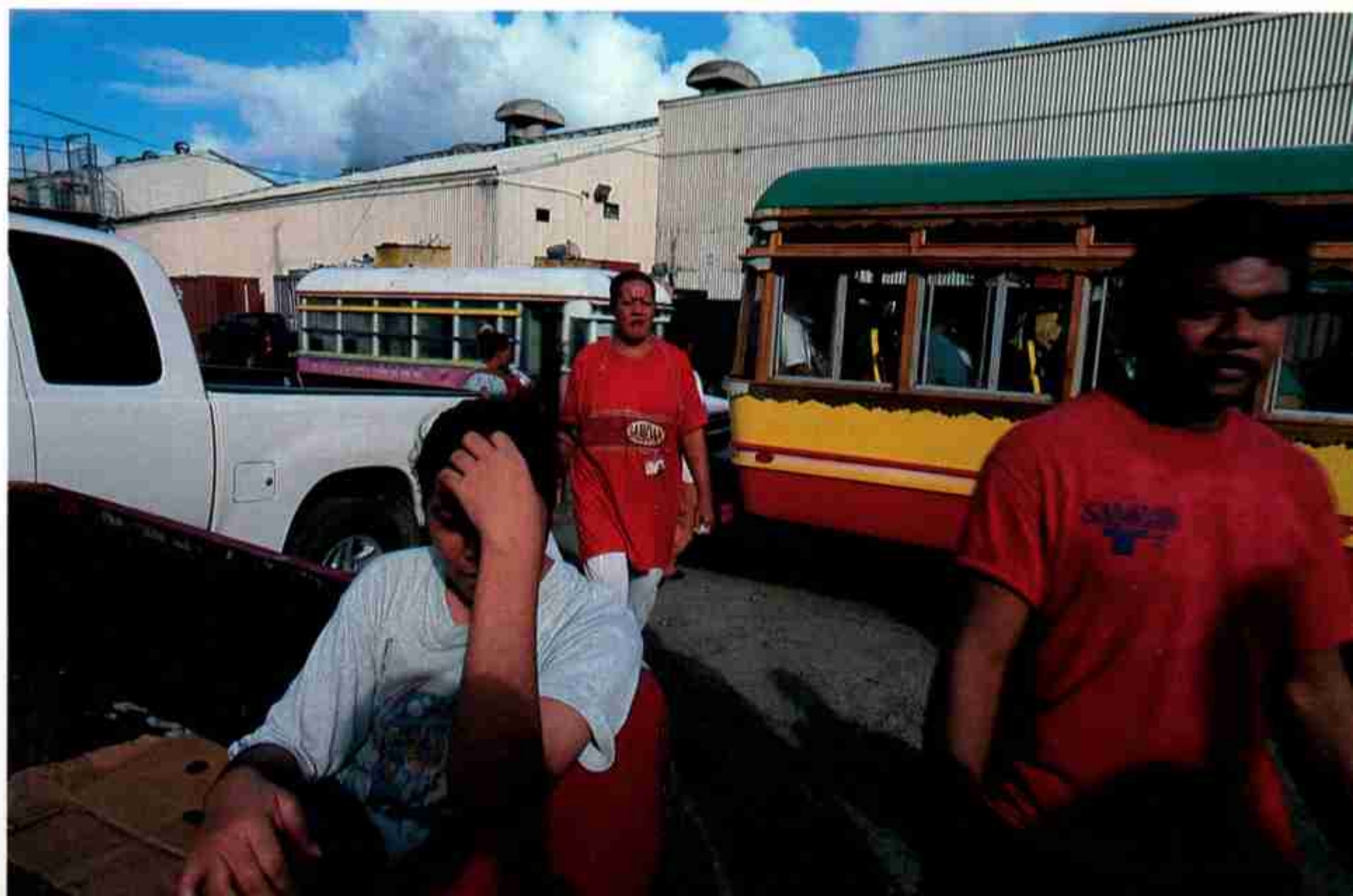
Another aspect of Christianity that islanders take seriously is the admonition to treat others with kindness. It makes an easy fit with long-standing customs of hospitality in a land of plenty. If you pass by looking thirsty, someone is likely to hand you a young, watery coconut. And whether you look hungry or not, strangers invite you home for a meal.

"‘Everyone is so nice!’ is the first sentence out of every visitor's mouth," says park superintendent Chris Stein. "At first outsiders can't quite believe it. They keep expecting to get hustled for something in return." Because the culture is such an integral part of the National Park of American Samoa, visitors are encouraged to stay in villages next to the reserve, either at the modest lodges or in the guest houses most families already maintain for friends and relatives passing through. This gives outsiders a better chance to get to know people like Mafuta, the healer, or her neighbor, Ta'au'au Utuone, who shows me how to make a fish-trap basket from the aerial roots of a rain forest tree and braided coconut fibers. The financial benefits of providing food and lodging go directly to the local communities.

Park officials don't mind that the vacation resort industry has bypassed the territory, because mass tourism could place undue pressure on a limited environment inside the park and overwhelm the low-key atmosphere of the islands as a whole. No need to make Paka o Amerika Samoa into a crowd pleaser.

"I look at the Park Service as a vehicle for keeping as much as we can of Samoan learning and Samoan culture," Congressman Eni Faleomavaega tells me. "I don't want quick development that will kill us." Tauese P. F. Sunia, the governor, adds, "We have a fixed amount of land, yet our population is booming. We have to preserve the resources of this territory, and the park is the best way to do this. Whether anyone comes to visit or not is secondary."

Of course, not everyone is singing in harmony, even in paradise. Sitting in the palm shade along Ofu's coast, Toeaina Faufano Autele, then a representative to the territorial legislature, says: "We don't need someone from outside telling us what to do with our land. People are



beginning to realize that there will be regulations. The park said I can't take rocks for building from my family's part of this beach. Then I hear we can't build a pipeline across the park to deliver water to other families. I told the ranger I don't mind if tourists use my property. They are welcome to visit. That's our tradition. But please remove my land from the park."

Leota, the park's high-talking ranger, sees more opportunities than problems. "Every chief from every village has been in to talk to us," he says. "Most want to join the park. The main reason the reserve isn't getting larger by the year is that we don't want to end up leasing little pieces everywhere. We would rather add to existing units. And before we can do that, Congress has to revise the park boundaries."

THE NATIONAL PARK of American Samoa is the first contractual park in the U.S. system, but the ideas behind it are being tested in a number of places. Indigenous peoples in Alaska and in northern Canada and other countries have been granted subsistence rights within national parks. The Great Basin National Park in Nevada, established in 1986, allows sheep grazing and other economic activities. Though not so widely known, various National Park Service programs merely help fund and coordinate the efforts of state heritage agencies and private civic groups.

Parks are limited only by our inventiveness. I find myself pondering American Samoa's contribution as I hike the sea's edge in Ta'ū. Thick-trunked *futu*, or fish poison trees, border the beach with sprays of big, purplish, bat-pollinated flowers. Each flower blooms for a day and a night or two then drops loose. Strewn across the forest floor with their long, tentacle-like stamens waving in the breeze, the fallen blossoms look like sea anemones washed in by a storm tide. Villagers used to gather the fruits and mash them together and cast the mixture into shallow waters to capture fish stunned by the poison.

The woodland path crosses small plantations of taro, coconut, and banana within the park. Then I break out onto a rocky point and am met by mile upon mile of breakers rolling straight in off the Pacific to curl and surge against dark lava and untracked beaches spread below the mountain walls. An hour's walk down the coast—or is it two hours? and why should I care?—I dive from a mossy ledge into the pool below a thousand-foot waterfall, come spouting up into the sunlight, and realize that this is a place I always dreamed of but had almost given up hope of ever finding. As long as this is a park, that kind of hope need never dim. □

Leery of sharks, a spearfisher off Ofu trails a long stringer to keep a prudent distance from his catch. Many residents still fish and farm to sustain themselves, and park officials pledge that the influx of visitors will not upset the balance between Samoans and their natural heritage.

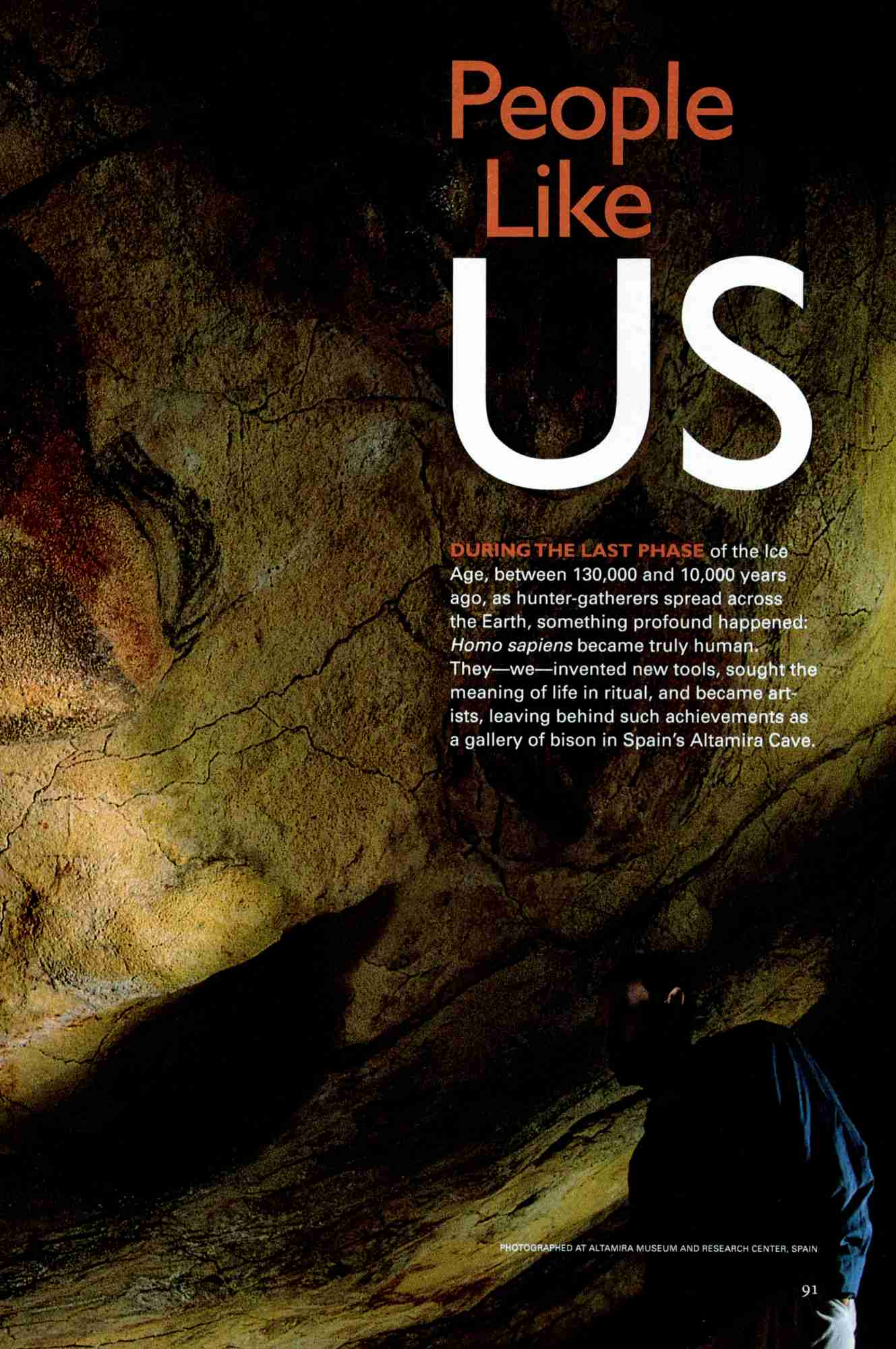




THIS IS A PLACE I ALWAYS
DREAMED OF BUT HAD ALMOST GIVEN
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THE DAWN OF HUMANS



A person wearing a blue jacket is seen from the back, looking up at a cave wall covered in ancient paintings. The wall is illuminated by a warm, yellowish light, highlighting the textures and colors of the rock and the artwork. The paintings include a large, dark, elongated shape on the left and various smaller, more intricate designs on the right.

People Like US

DURING THE LAST PHASE of the Ice Age, between 130,000 and 10,000 years ago, as hunter-gatherers spread across the Earth, something profound happened: *Homo sapiens* became truly human. They—we—invented new tools, sought the meaning of life in ritual, and became artists, leaving behind such achievements as a gallery of bison in Spain's Altamira Cave.

PHOTOGRAPHED AT ALTAMIRA MUSEUM AND RESEARCH CENTER, SPAIN



17,000-10,000 YEARS AGO/FRANCE

The haunting visage of a girl, her eye sockets masked in bone, stared out at excavators in Mas-d'Azil Cave. Like many of the 300 decorated Ice Age sites found in Europe, Mas-d'Azil served as campground and ceremonial center.







By RICK GORE SENIOR ASSISTANT EDITOR

Photographs by KENNETH GARRETT

Art by GREGORY MANCHESS

DEEP IN the Australian outback, Alice Kelly, a white-haired elder of the Muthi-muthi people, draws relentlessly with felt pens on a white pad. To me her drawings look like colorful scribbles, but Kelly says they are her Dreaming, a vision from a time beyond memory yet still persisting, a time in which ancestral beings move across a barren Earth, shaping the landscape. It is a time filled with mythical spirits, sacred places, and animal totems.

The Dreaming varies from tribe to tribe, but its roots go back to the people who came to Australia during the Ice Age. A part of Alice Kelly still lives in the Dreamtime, and as I watch her draw, I feel a pang of envy. She must sense that. She looks up.

"All Aborigines are born artists," she says. "You would be too, but your culture has driven it out of you."

I have come to Mungo National Park to search for the answer to a question: When

28,000-24,000 YEARS AGO/CZECH REPUBLIC

Ancient landmark, the 2,000-foot-high Pavlov Hills once supported a string of prehistoric seasonal camps. At the hill sites of Dolní Věstonice and Pavlov, researchers have found evidence of the earliest known ceramics and textiles.



ARTIFACT FROM MORAVIAN NATIONAL MUSEUM, BRNO, CZECH REPUBLIC

27,000 YEARS AGO CZECH REPUBLIC

Unmistakably female, a clay figurine from Dolní Věstonice resembles dozens of other statuettes with exaggerated anatomy that appeared in Europe from 27,000 to 20,000 years ago. The Venus figures have been described as fertility symbols, but specialists insist that their true meanings are lost to us. As glaciers approached their maximum extent 20,000 years ago (map), a worsening climate forced the abandonment of northern sites.

did the modern human mind evolve? When did we as a species emerge from the fog of tentative consciousness that we share with the rest of the animal world and become problem solvers, creators of art, and inventors of ritual and infinite technologies? Most anthropologists think humans made the leap during the final phase of the Ice Age, sometime between 130,000 and 10,000 years ago. No one can say exactly where or when the mental transition occurred. But Alice Kelly has a strong opinion.

"The first creative people were the Aborigines," she says flatly. "Creation began right here in this land."

I have just returned from a walk with Kelly

KENNETH GARRETT has photographed more than 20 articles for NATIONAL GEOGRAPHIC, including most of the Dawn of Humans series. Award-winning artist GREGORY MANCHESSE illustrated "Searching for the Scythians" in the September 1996 issue.

into a dune field where a woman she regards as her ancestor was buried tens of thousands of years ago. The remains of this ancestor, known as the Mungo Lady, were discovered in 1968.

"She was between 20 and 25 when she died," says Alan Thorne, an Australian anthropologist who has studied the Lady's burial. "Her people placed her body on a funeral pyre, and after the fire consumed her flesh, they smashed her bones with a club or a digging stick. Then they placed the fragments in a hole at the front of the dune."

Today the Mungo Lady's burned bones reside nearby in a vault at the Mungo National Park headquarters, where Aboriginal custodians look after her. "She is very symbolic to our people—she tells the Aboriginal people of their origins. She came out of the ground to guide us," Kelly told me. "Who else would bring *you* here from the other side of the world?"

FOR MANY YEARS the earliest archaeological evidence for modern behavior came from Europe. It was attributed to people named by 19th-century archaeologists after Cro-Magnon, the French rock-shelter where their fossils were first discovered in 1868. Some specialists believe that the appearance of modern humans—who replaced our close cousins, the Neandertals, the occupants of Europe from 230,000 to 30,000 years ago—indicated a change in the wiring of the human brain. This change would have enabled people to invent such technologies as boatbuilding, which then helped them spread throughout the world.

The Mungo Lady, along with a contemporary male fossil, originally dated at 24,000 years ago—well after modern art and technology had emerged at European sites—seemed to fit that migration scenario. But in 1999 a team of Australian researchers led by Thorne redated the sediments where the Mungo people were buried. Three different dating methods indicated an age of about 62,000 years. These dates remain a matter of considerable controversy. The earliest Cro-Magnon fossils in Europe date from about 32,000 years ago. So if the Mungo dates are correct, modern humans were afoot in Australia at least 30,000 years before we find fossil evidence for them in Europe.

Today most scientists believe that modern human behavior arose in Africa—before the

appearance of Cro-Magnon humans in Europe—and that the Cro-Magnons of Europe, with their African builds, originated in Africa. The Mungo people probably had African roots too, their new dates implying that modern people spread eastward from Africa before others of their species populated the colder latitudes of Europe.

Until recently there was little evidence for modern behavior in Africa as early as the Mungo dates, but a spectacular new trove of modern-looking artifacts has come from a remote site called Blombos Cave at the southern tip of South Africa. Christopher Henshilwood of the State University of New York at Stony Brook and Judith Sealy of the University of Cape Town excavated the objects, which are probably more than 70,000 years old. A visit to Blombos with Henshilwood gives me a glimpse

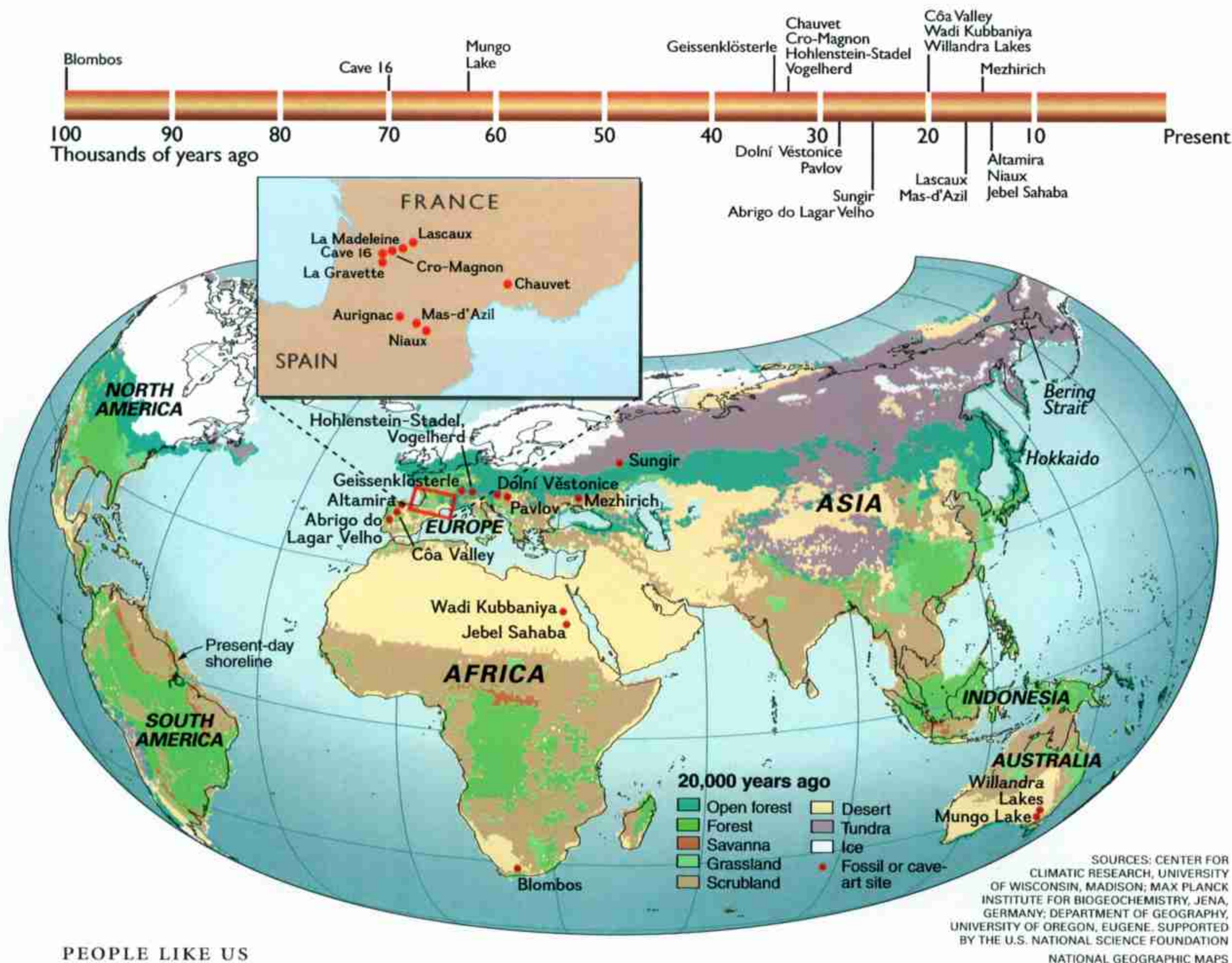


of our species perhaps on the cusp of transition.

We drive from Cape Town about 185 miles east to a windswept stretch of coast. Hiking out over dunes that Henshilwood explored as a boy, we

watch huge waves from the direction of Antarctica break offshore and roll onto the beach far below.

Blombos Cave opens up like a mouth in the dunes; we enter through a 25-foot-wide slit in the earth and head for a pile of sandbags. “Beneath these bags is the debris of a people who once lived here,” says Henshilwood. “We have found more than 30 bone tools, including awls and possible spearheads.” Well-developed bone-tool industries did not appear in Europe until around 40,000 years ago, and archaeologists have long considered bone working a marker of modern human behavior.





HUNTER-SCAVENGERS

A brown bear is held at bay by a ring of spears after disrupting a hunting party gathered around the carcass of a woolly mammoth. The action takes place on the northern steppes in a scene depicting the trials of subsistence 26,000 years ago.

Researchers have questioned the traditional image of what anthropologist Olga Soffer calls the “macho, Hemingwayesque big-game hunter.” She and other scholars believe that very few of the huge mammoths were stalked and killed but rather



ARTIFACT FROM NATIONAL ACADEMY OF SCIENCES OF UKRAINE, KIEV

that most were scavenged after dying of natural causes. The discovery of meshlike impressions on clay fragments in the Pavlov Hills also leads to speculation that family members set nets for catching small game like hares, foxes, and squirrels.

Judging from bone debris, such quarry provided a good share of the camp calories. Bone needles (left), used to sew the hide and fur garments that helped modern humans expand into the cold latitudes, appear at this time.



BOTH PHOTOGRAPHED AT SOUTH AFRICAN MUSEUM, CAPE TOWN

100,000-70,000 YEARS AGO SOUTH AFRICA

Discovery in a South African cave of cross-hatched ochre (above) and expertly crafted stone points (below) suggests that modern human behavior began much earlier than previously thought. Chris Henshilwood of the State University of New York at Stony Brook, chief excavator at Blombos Cave, sees the ochre markings as an early use of symbolic motifs. The ochre could have been used for body decoration. Henshilwood wonders whether the exquisite points were perhaps symbolic as well as functional tools. It was unnecessary, he argues, "to produce an item of this standard simply so it could be thrown at an animal."



The team has also found advanced stone tools that look like spearheads. Some, says Henshilwood, are serrated and crafted with a delicacy and skill not seen in Europe until about 22,000 years ago. They are made not from local quartzite but from material that came from 10 to 20 miles away: As today's craftsmen would, the Blombos humans took the trouble to import a preferred material for their work.

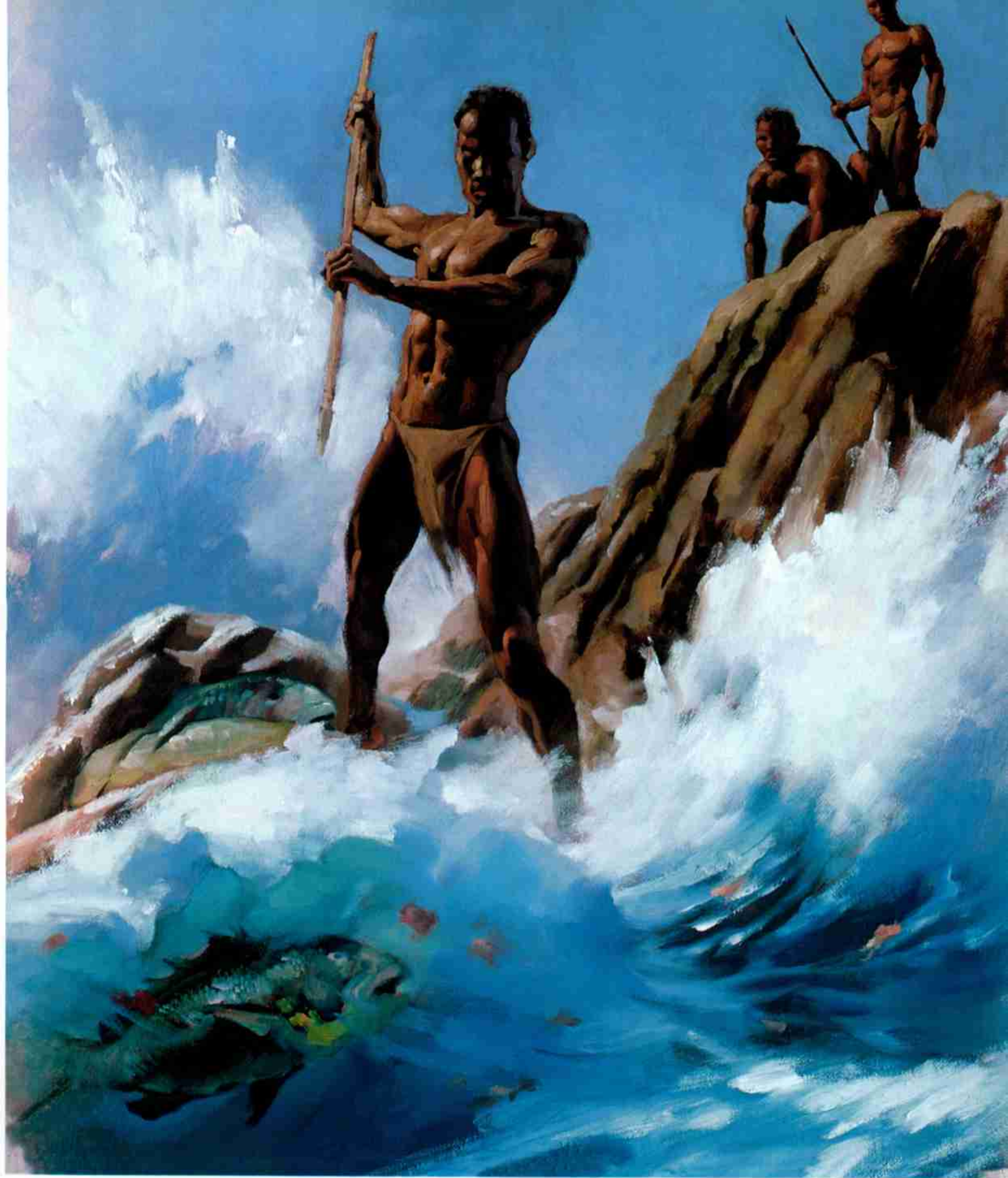
The site has produced hundreds of other pieces that were scraped and grated by the Blombos people to produce a powdery pigment they might have used to paint their bodies or belongings. Two pieces of ochre show cross-hatched lines. "The design is too regular to be accidental," says Henshilwood. "They represent something. They indicate early evidence of symbolic thinking. Had they been found at a later Ice Age site in France, they'd be called art objects."

One of Blombos's biggest surprises was the presence of bones from fish that weighed as much as 50 pounds. "Most are reef fish," says Henshilwood. "We haven't found any bone hooks, so we suspect they were lured into rocky inlets with bait and then speared." To lure fish requires the more advanced planning, anticipation, and other cognitive traits specialists have long associated with the modern human mind.

"I think language is the key to it all," Henshilwood says later as we relax by the shore. "Language requires syntax—the ability to join a series of ideas together. A parrot can learn to recognize about 50 words, but it has no syntax. One parrot can't say to another: 'Let's go down to the sea and catch fish and then come back here and make a fire and drink some beer and paint our bodies.'"

DESPITE THE EARLY glimmerings of modern behavior that are appearing far from Europe, that continent still contains the best record of how the Ice Age mind was evolving. The first artifacts that look modern began appearing there around 42,000 years ago, and scholars have long attributed them to newly arriving people.

The Cro-Magnons apparently diffused in waves through a landscape sparsely inhabited by Neandertals. Archaeologists call the earliest Cro-Magnon stone-tool industry in southwest



TASTE FOR THE SEA

The human diet grew richer some 70,000 years ago with the advent of fishing skills in Africa, birthplace of *Homo sapiens*, or “wise man.” From the presence of fish bones found in Blombos Cave on the South African coast, excavators believe that its inhabitants must have conceived ways to lure fish

close to the shore where they could be speared. Many bones came from a large fish called a black musselcracker, still found in these waters. Scholars theorize that the planning and execution involved in catching fish reflected the growing ability of people to share information through language.



PHOTOGRAPHED AT AUSTRALIAN NATIONAL UNIVERSITY, CANBERRA (ABOVE); PHOTOGRAPHED AT AUSTRALIAN MUSEUM, SYDNEY



60,000-20,000 YEARS AGO/AUSTRALIA

As big as a rhinoceros, a plant-eating marsupial called a diprotodon browsed the interior of Australia more than 60,000 years ago, when humans are now believed to have reached the continent. Scholars think the newcomers sailed on rafts from Indonesia. The eventual disappearance of the diprotodon along with a third of Australia's other mammal species may explain the development 30,000 years ago of the earliest known grinding stones for plants. Archaeologist Richard Fullagar of the Australian Museum in Sydney compares an early fragment with a recent grinding stone. The Willandra Lakes skull (above), some 20,000 years old, puzzles scientists since it shows more primitive features than much older Australian remains.

Europe the Aurignacian, after the French site of Aurignac. All across Europe, Aurignacian-age people produced an abundance of blades and bone tools, which Neandertals rarely made. And the period, which lasted until around 28,000 years ago, brought something else—something never before seen in Europe.

"Almost everywhere we find the Aurignacian we also find art," says Nick Conard, an archaeologist at the University of Tübingen in Germany, as we drive across rolling green farmlands on the edge of the Danube River Valley to a cave called Vogelherd. There in 1931 archaeologists uncovered a cluster of ivory figurines that have since been dated at about 32,000 years ago. Conard has brought along several of those figurines—a mammoth, a wild horse, and two cats—to be photographed.

"This is the first time since their discovery that these objects have been back here," he says, setting the animal figures on an altarlike ledge inside the cave. Only a few inches long and etched with X-marks and crosshatches, they represent a momentous transition.

"Look at this horse," says Conard, handing me a simply carved but beautiful figure (page 104). "The person who made that was without a doubt someone like us."

Aurignacian people left an even more impressive piece of art at a neighboring site called Hohlenstein-Stadel. Known as the *Löwenmensch*, or lion-human, this foot-tall creation combines the head and upper body of a cave lion with the upright posture and legs of a human being.

Kurt Wehrberger, curator of archaeology at



the city museum of Ulm, pulls on white gloves, takes the Löwenmensch out of a wooden box, and smiles proudly. “When it was discovered in 1939,” he says, “the Löwenmensch was broken into about 200 pieces.”

He hands me the reassembled figurine. It would be a masterpiece in any age. Holding it, I can sense the awe its creator must have felt for the cave lions that prowled the Ice Age world. It speaks of a moment when the human imagination was young—when, like this man-beast itself, our ancestors were striding out of the animal past.

Another Aurignacian art trove emerged in late 1994 when three French spelunkers, Jean-Marie Chauvet, Eliette Brunel, and Christian Hillaire, were exploring a small cave above the Ardèche River in southeastern France.

The three noticed a draft coming from a pile of rocky debris at the back of the cave, and when the group cleared away the stones, they found a narrow passageway that led them into a vast, 50-foot-high chamber littered with the bones of cave bears. Haunting images of lions, rhinoceroses, bears, and a panther decorated the walls of side chambers.

The Chauvet paintings, masterfully executed, reveal a fully developed sense of perspective. Experts assumed that the artwork was created late in the Ice Age as in other famous painted caves—Lascaux in France and Altamira in Spain—between 14,000 and 17,000 years ago. What puzzled them was that the art at Altamira and Lascaux focused almost entirely on animals humans hunted, such as horses and bison, while the Chauvet art included a



ARTIFACTS FROM EBERHARD-KARLS UNIVERSITY, TÜBINGEN, GERMANY

ABOUT 32,000 YEARS AGO GERMANY

Potent image from a distant, animal-dominated past, the *Löwenmensch*, or lion-human (opposite), surfaced after nearly 50 years in museum storage, where it lay in 200 pieces. Carved from a mammoth's tusk, the foot-tall figure was found inside the Hohlenstein-Stadel Cave near the Danube River Valley, a possible migration route of modern humans into Europe from the Middle East. Masterpieces from Vogelherd Cave include an ivory horse and mammoth (below), their sides rubbed smooth by handling. Discovery of a musical instrument, a bone flute from Geissenklösterle (above), confirms the existence of an aesthetic consciousness.



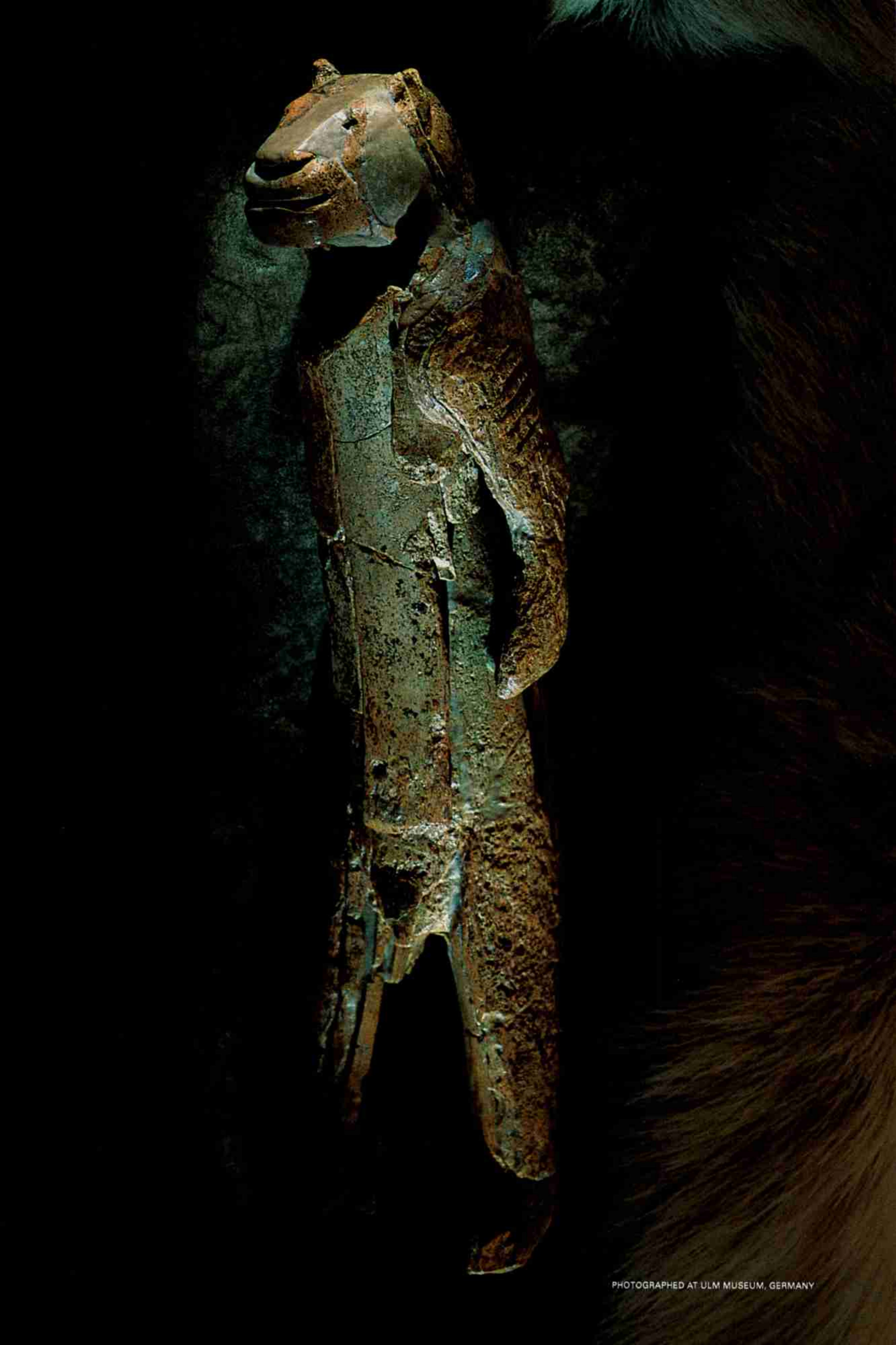
striking number of animals that were dangerous to humans.

When radiocarbon dates of the Chauvet paintings indicated they were about 32,000 years old, the animals suddenly made more sense. The paintings were Aurignacian, created by people with the same primal awe of dangerous animals as those who carved the *Löwenmensch*. In fact, the Chauvet Cave also contains a painting of a composite man-beast.

ALTHOUGH ARCHAEOLOGISTS have traditionally connected the appearance of the Aurignacian technology and art with the arrival of new people, many now suspect the Neandertals were also evolving toward modernity. They point out that the earliest known modern human fossils in Europe are about 10,000 years younger than the earliest Aurignacian tools. New evidence from Neandertal sites in France indicates that our supposedly "dumb" cousins were indeed making Aurignacian-like artifacts by 38,000 years ago. "In southwestern France," says French archaeologist Jean-Philippe Rigaud, "it looks like Neandertals had made the transition to modern technology before the Aurignacians arrived."

It is possible that the capacity for what we consider modern thinking evolved far back in the *Homo* lineage before the Neandertals split off and that the capacity simply wasn't useful until the Aurignacian era, when Europe began to fill up and its inhabitants—Neandertals and newcomers alike—needed more sophisticated social skills and technological talents to thrive.

The debate among Ice Age specialists over the nature of the Neandertal mind has been fueled by a discovery in late 1998 near the town of Fátima in the Portuguese countryside. There two archaeologists, João Maurício and Pedro Souto, were investigating reports of rock art in the Lapedo Valley, a region filled with caves and rock-shelters. In a spot called Abrigo do Lagar Velho a local landowner had recently cut a road, and where his bulldozer had exposed the base of a rock face, the two men saw evidence of a prehistoric human campsite—bits of bone, stone tools, and charcoal from ancient hearths. They also discovered the bones of a child who was buried there 25,000 years ago. Working in cold December rains, archaeologists and physical





PHOTOGRAPHED AT NATIONAL MUSEUM OF PREHISTORY, LES EYZIES-DE-TAYAC, FRANCE

70,000-12,000 YEARS AGO FRANCE

Telltale hearth illuminates the history of a cave in frequent use for 60,000 years, first by Neandertals, a people who failed to survive the arrival in Europe of modern humans. A dark soil layer near the entrance of Cave 16 in Le Conte cliffs shows archaeologist Jean-Philippe Rigaud where Neandertals made fires, probably for heat, light, and protection. Modern humans settled both at the cave entrance and farther inside. The appearance in Europe of barbed harpoons (above) and more efficient points (below) testifies to the development of new hunting skills.



anthropologists under team leader João Zilhão recovered all of the child's body but the skull, which had been crushed and scattered by the bulldozer.

They determined that the child was probably a four-year-old boy. His body had been stained with red ocher. A pierced shell, possibly the remains of a pendant, lay at his neck. Three pierced deer teeth lay near the scattered pieces of his skull; the teeth perhaps decorated a hat that had long ago decayed. His burial was by far the oldest ever found in Iberia, and it resembled those in central and eastern Europe dating from around the same time.

After one of the world's leading experts on Neandertal anatomy, Erik Trinkaus of Washington University in St. Louis, examined the bones, he made a startling conclusion: Though the child in many respects looked like other Cro-Magnon skeletons, it had certain traits, including cold-adapted limb proportions, that were typical of Neandertals.

"The kid's a mosaic throughout its body," says Trinkaus. "I can explain it in no other way than that it's a hybrid."

Trinkaus's interpretation has provoked heated debate. Two species aren't supposed to interbreed, and many specialists have preferred to keep the species separate.

"Neandertals have been out of favor since they were first discovered," says Zilhão. "They were the brutes. Some people didn't think they had language or culture. But this child is knocking down the last stronghold of those who believe in Us-as-Special."

As far as we know, Neandertals left behind little if any art. For some reason Europeans of the Aurignacian period needed to express themselves in pictures and figurines. Why?

"Like us, they were individuals in search of meaning," suggests Meg Conkey, an archaeologist at the University of California at Berkeley. "They must have been developing a social fabric that gave meaning to that art."

SOME 7,000 YEARS after the Chauvet paintings, a new tool industry called the Gravettian, for the French site La Gravette, emerged in Europe. The people of this period were tall and strong; they were also well fed, thanks to handheld spear-throwers, which made hunting more efficient and less risky. They developed sewing needles with





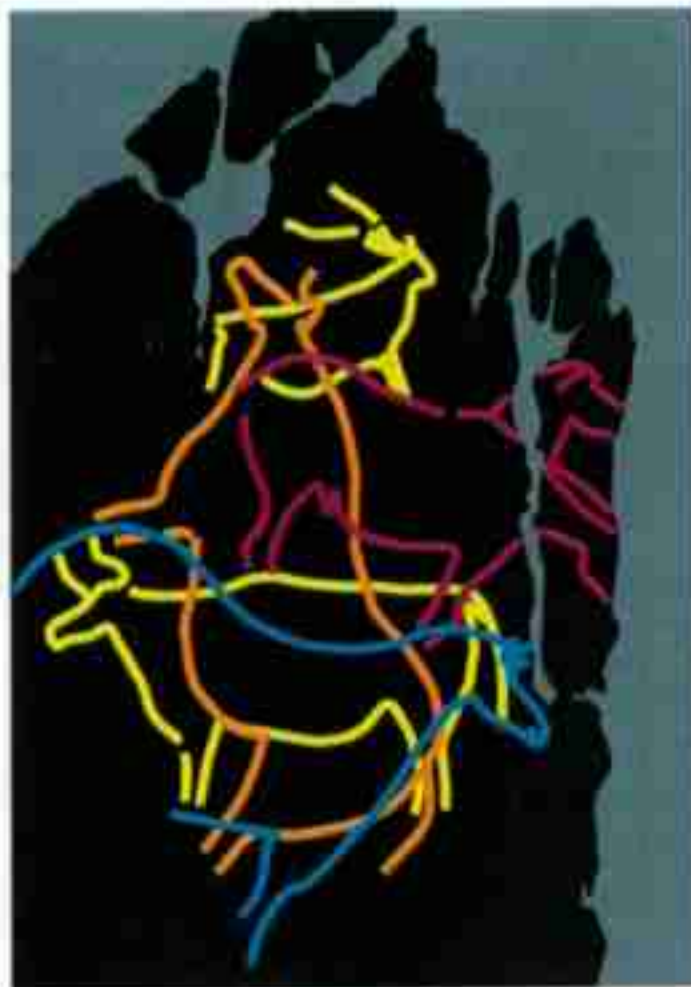
MINISTRY OF CULTURE, D.R.A.C. RHÔNE-ALPES (ABOVE); NATIONAL GEOGRAPHIC ART DIVISION (BELOW LEFT)

32,000-20,000 YEARS AGO/France and Portugal

A bestiary of horses, aurochs—an extinct species of ox—and dueling rhinoceroses immortalizes a wall in France's Chauvet Cave. Discovered in 1994, the cave stunned scholars with the quality and age of its

paintings, some of them 32,000 years old.

"It has changed our view of the evolution of art," says scholar Jean Clottes. "People can no longer say art evolved from crude beginnings." Why did artists fill walls with images of animals? Did they hope to ensure the fertility of favored prey? To mark their turf? In an artist's conception (right), a hunter etches an aurochs on a rock 20,000 years ago. Later artists use the same wall to add their own work, shown by different colors in the tracing (left) of an engraving in Portugal's Côa Valley.



which they made not only weather-resistant clothing but fashion statements as well—in the form of beads, animal teeth, and shells artistically sewn on hide garments.

Two sites in the Czech Republic near the villages of Dolní Věstonice and Pavlov have helped illuminate the richness of the Gravettian world. The residents of these settlements relied heavily on meat, bones, and hides. They cooked stews and gruel in pits they lined with hides and then heated with hot rocks. They also manufactured the world's first ceramics.

"They knew that extreme heat would change the chemistry of clay," explains Martin Oliva of the Moravian Museum in Brno as he shows me delicately shaped clay animals and human figurines recovered from Dolní Věstonice.

Recently scientists have been coaxing new

surprises from the debris of both sites. A fire once ravaged Pavlov. Jim Adovasio and David Hyland of Mercyhurst Archaeological Institute have analyzed hundreds of little brown clay chips recovered from the floors of dwellings that burned. Many of the chips contain the impressions of textiles, cords, and baskets that were left in the clay floor and then hardened during the fire.

Adovasio and his colleague Olga Soffer of the University of Illinois believe the impressions prove people were making a variety of textile items: mats, wall hangings, bags, blankets, and cloth. "Theirs was the earliest textile industry in the world," says Soffer. "It's a technology we'd associated with the Neolithic period thousands of years later."

Soffer is particularly taken with the idea that



these groups were making hunting nets. She has long disputed the prevalent theory that many Ice Age humans hunted mammoths to survive. Soffer notes that the Moravian sites are littered with the bones of small furbearing animals, especially hares. Hares would have been difficult to catch without nets. They would also have been a source of protein and fur—and much safer to go after than mammoths. “If Ice Age humans were such big brave mammoth hunters, why are we finding all these bunnies?” she asks.

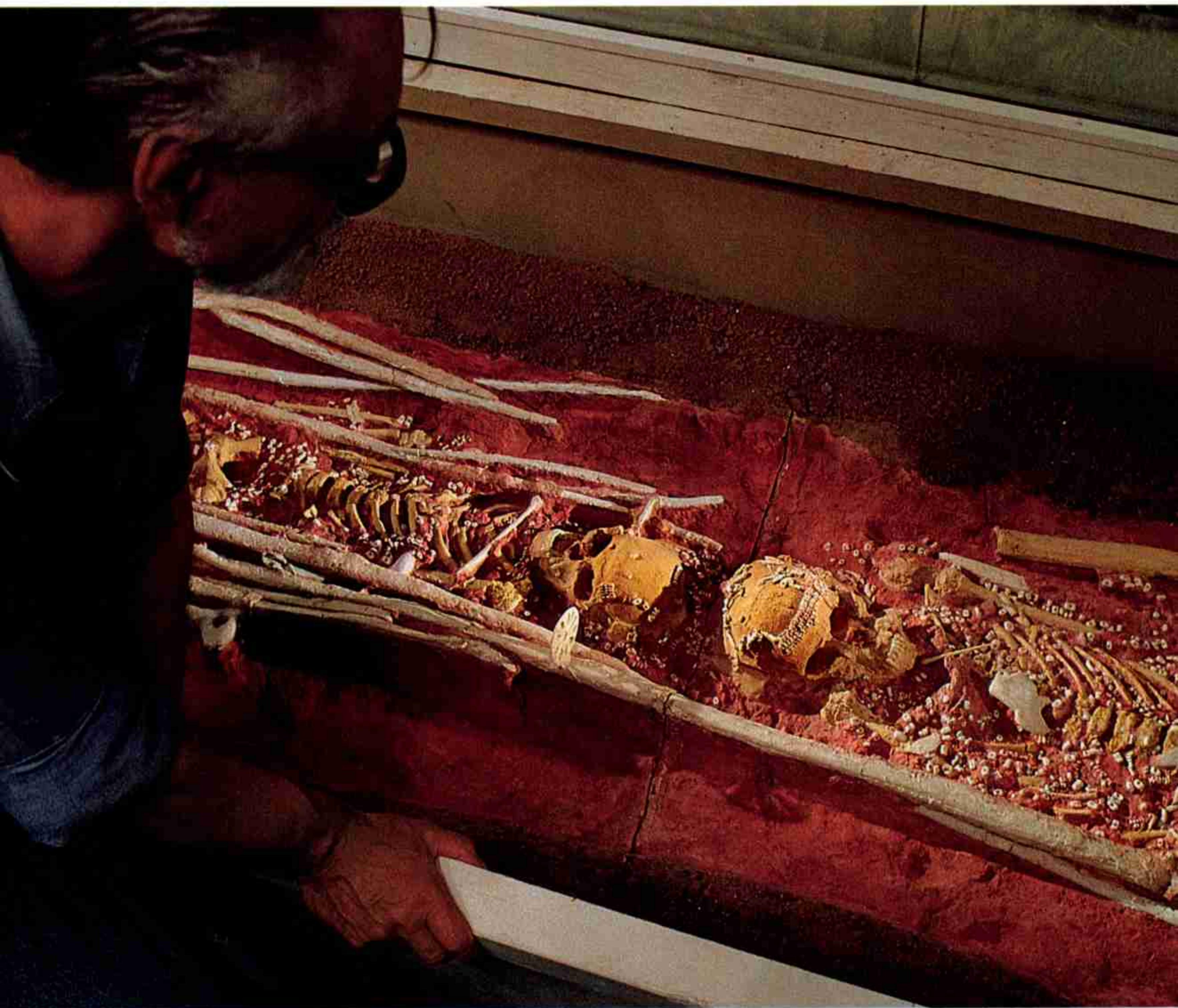
“The nets might have been as big as 300 feet long and three feet high,” says Adovasio. “You would have needed 25,000 knots to make one that size. Everyone in the group would have had to have been working on it.”

Gravettian-age people had also developed

elaborate funeral practices. I am witness to one of the most fascinating of them in the Vladimir Historical Museum in Russia. Replicas of the skeletons of two children—a boy and girl around 13 or 14—lie head to head in a museum case, just as they were found in 1969 at a nearby site called Sungir.

The children apparently were buried at the same time. About 3,000 ivory beads that were attached to the clothing in which they were buried surround each one. Lines of beads along the boy’s legs indicate that he wore trousers. Rings of beads below his knees suggest boot tops. His belt and hat were decorated with arctic fox teeth, and on his pelvis lay the teeth of a cave lion.

Surrounding the children are animal figurines and carved disks that may imply a



sun-moon cult. Eleven dartlike spears, three daggers, and two longer spears also were found in the grave. One of those spears, eight feet long and made from a mammoth tusk, lies next to the boy.

"It appears this was an unusual ritual burial, unusual in its wealth and ornaments," says Nicolay Bader, the excavation director.

The burial suggests that social hierarchies had begun to emerge in some Ice Age societies. Children of that age could not have accumulated such wealth. Very likely they belonged to a powerful family, or there was something special about their deaths that prompted their tribe to bury such treasures with them. Nearby, excavators also found skeletons of a man and woman from roughly the same period.

The following day Bader takes me to the

Laboratory of Anthropological Reconstruction in Moscow, where Galina Lebedinskaya, a forensic artist, has been creating clay busts of these skeletons. The children look like kids you might meet in St. Petersburg today. The man resembles Yul Brynner. Lebedinskaya is still working on the woman, who looks a bit stern. "This is the kind of woman," says Lebedinskaya, "you can imagine would demand strictly of her husband: 'Where is that mammoth you did not kill today?'"

BY AROUND 22,000 YEARS AGO global temperatures had plunged again; they reached their low point—what scientists call the glacial maximum—about 20,000 years ago. Ice sheets advanced, and most of Europe, except



BOTH PHOTOGRAPHED AT VLADIMIR HISTORICAL MUSEUM, RUSSIA

25,000 YEARS AGO/RUSSIA

Extravagant for its time, the grave of two children found at an Ice Age hunter's camp near Sungir disclosed a wealth of ornaments and weapons, the earliest known clues that status and hierarchy were redefining human society. About 6,000 ivory beads accompanied the bodies in an ochre-lined grave, a replica of which is on display in a Vladimir museum (left). The beads apparently decorated garments—long pants, knee-high boots, caps, and short cloaks. Other grave goods included spears, daggers, and smaller items like a cloak pin, a horse figurine, a disk, and hundreds of drilled arctic fox teeth from a belt (above). The skeleton of a woman was buried above the children. Nearby in another elaborately adorned grave lay the remains of a man about 50 years old, buried as long as a thousand years after the children.

for the southern regions, was abandoned.

Along with the cold, intense drought gripped most of Africa. One of the few places on the continent with significant water resources was the Nile Valley, and it is here, at a place called Wadi Kubbania, that scientists have uncovered the earliest evidence of humans killing one another.

On a cool winter morning I drive north from Aswan, watching the white sails of the feluccas on the fast-flowing Nile. It's hard to imagine that 20,000 years ago this mighty river didn't carry enough water to flow straight. It meandered in bends and oxbows, and its seasonal floods pushed into the wadis, or valleys, watering the nutesedge, attracting game and waterfowl in winter, and drawing enormous numbers of catfish in spawning season.

No hint of those ephemeral marshes remains. Wadi Kubbania today is a wilderness of dry sand and dark rock. But beneath the barren sands a team led by Fred Wendorf, an archaeologist at Southern Methodist University, uncovered in 1982 the 20,000-year-old skeleton of a young man with two spearpoints embedded in his pelvic bones. Both bones in his forearm had been broken, probably from warding off a blow, and a spearpoint surrounded by partly healed bone was embedded in his upper arm.

"He'd been in three scraps, separated by at least several months," says Wendorf. "The last one got him."

Wendorf believes that as the climate deteriorated, people began fighting over the scarce resources of the Nile. And over time the



conflicts intensified. At Jebel Sahaba, a 14,000-year-old site to the south in Sudan, Wendorf's team found a graveyard filled with bodies that had been speared or clubbed. "It looks like organized, systematic warfare," he says.

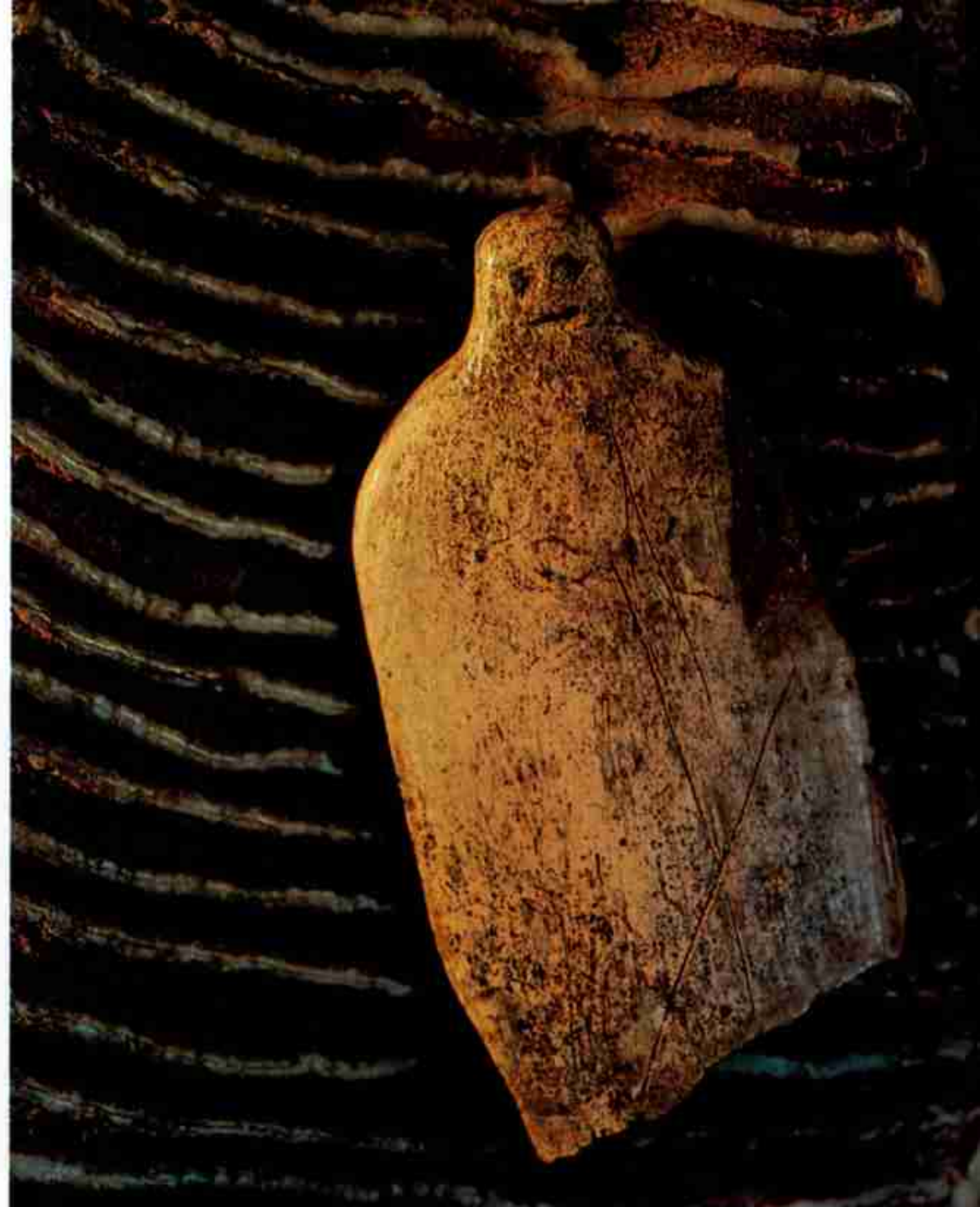
As the global climate began warming again, glaciers retreated, and people moved back into much of Europe. In Asia new groups of humans were moving into Japan, possibly island hopping from the south. They soon gave rise to the first major culture there, the Jomon, at the end of the Ice Age.

In Europe the warmer weather brought abundant plant foods that fed great herds of reindeer and bison, which migrated along the river valleys of Europe. Humans not only hunted the herds, they also began fishing with hooks, exploiting the salmon that flourished in

the rivers. Here in the final millennia of the Ice Age, a period known as the Magdalenian after a rock-shelter settlement called La Madeleine, well-fed populations rebounded, and new forms of social organization emerged.

Near the village of Mezhirich in Ukraine I visit a village complex of four huts built about 15,000 years ago from mammoth bones and tusks. Only round foundations remain. The huts took enormous effort, says Valeriy Suntsov, a Ukrainian archaeologist. The foundations alone contain the mandibles of more than a hundred mammoths. These structures may have been an early attempt to mark the landscape with distinctive architecture.

A series of pits dug into the permafrost near the huts may have served as freezers where meat could be stored indefinitely—



ARTIFACT FROM NATIONAL ACADEMY OF SCIENCES OF UKRAINE, KIEV

15,000 YEARS AGO UKRAINE

Jawbone by huge jawbone a hut's outer wall once took shape in Mezhirich, where families built a cold-weather refuge out of woolly mammoth remains. Above a base of mandibles at one of four bone huts (left), builders piled skulls and other large bones and for the roof arranged tusks and likely covered them with hides. The bones were probably hauled from a nearby "graveyard" where mammoth bones had accumulated. Sheltered from the harsh cold of the steppes, inhabitants skinned animals, repaired tools, and carved ivory figurines, including a ghostly piece shown on a mammoth tooth (above).

a permanent food supply. That supply, says Olga Soffer, would have "tethered people to one location," encouraging them to give up their mobility and to fall under the control of whoever ruled the camp—a major change in social organization.

Ice Age societies elsewhere in Europe were also growing more complex. Sites such as the huge cave of Mas-d'Azil in southern France became gathering spots where people came to exchange goods and gifts or to find mates. They also came often to a cave called Niaux in the French Pyrenees.

"It is a little spooky," says Jean Clottes, a French rock-art specialist, as drops of water from the ceiling of Niaux Cave fall and echo in the cold, dark void surrounding us. For more than half an hour I have been following Clottes





FRED WENDORF (OPPOSITE)

ever deeper into the earth, guided by the beams from our flashlights and our miners' headlamps. Some 14,000 years ago small groups of Magdalenian people dressed in hides ventured down this same path, their flickering torches casting shadows on the cave walls, to communicate with the spirits that ruled their universe.

"Imagine how this place must have seemed to them," says Clottes, who has been exploring such sites for most of his 67 years. "They had entered the underworld. They must have felt that spirits were lurking all around them."

Soon those spirits begin to reveal themselves to us as well. At the entrance to a cul-de-sac known as the Salon Noir, Clottes shines his flashlight on the dank wall. The eyes of a bison glare back.

"Ice Age people probably believed that animal spirits lived in the rocks," says Clottes. He moves his flashlight to the bison's hump, painted over a natural bulge in the cave wall. "See how they used the natural relief—bumps and cracks that reminded them of a particular animal's body—to locate those spirits?"

Many traditional people today also think this way, he adds, recounting a story of Inuit sculptors who several years ago were brought to Europe from the Arctic to demonstrate their art. One was asked to carve a bear from a particular rock. He refused, saying that there was no bear in the rock but rather a seal.

"You must remember that Magdalenian populations were still very small," says Clottes as we continue down into the depths of Niaux Cave. "They were lost in a sea of animals. And

14,000 YEARS AGO NILE RIVER VALLEY

Always a precious resource, the Nile River (above) flows stronger today than it did during the Ice Age. Archaeologist Fred Wendorf, who in the 1960s excavated a remote Sudanese site at Jebel Saha-ba, speculates that population pressures and a scarcity of food on the narrow Nile floodplain provoked competition that led to war. A burial ground from the site has produced the earliest known evidence of organized warfare. Almost half the 59 men, women, and children found in the graves died violently, including two men whose remains are riddled with stone points, their positions shown by pencil points (opposite). Two children had points embedded in their skulls.



PRESENT/JAPAN

Descendants of Japan's late Ice Age people, the indigenous Ainu struggle to keep traces of a premodern culture alive, performing the *hararaki*, or crane dance, on Hokkaido Island. Scholars are unsure of the route the Ainu's ancestors, the Jomon, took to Japan. However, their traditional animistic beliefs, centered around a bear cult, and their familiarity with travel by dugout canoe (right) provide glimpses of their ancestors' way of life.

Rising temperatures and the emergence of agriculture and permanent settlements marked the end of the Ice Age, a spectacular epoch that saw our species—innovative, spiritual, and adventurous—stake its claim throughout the world.

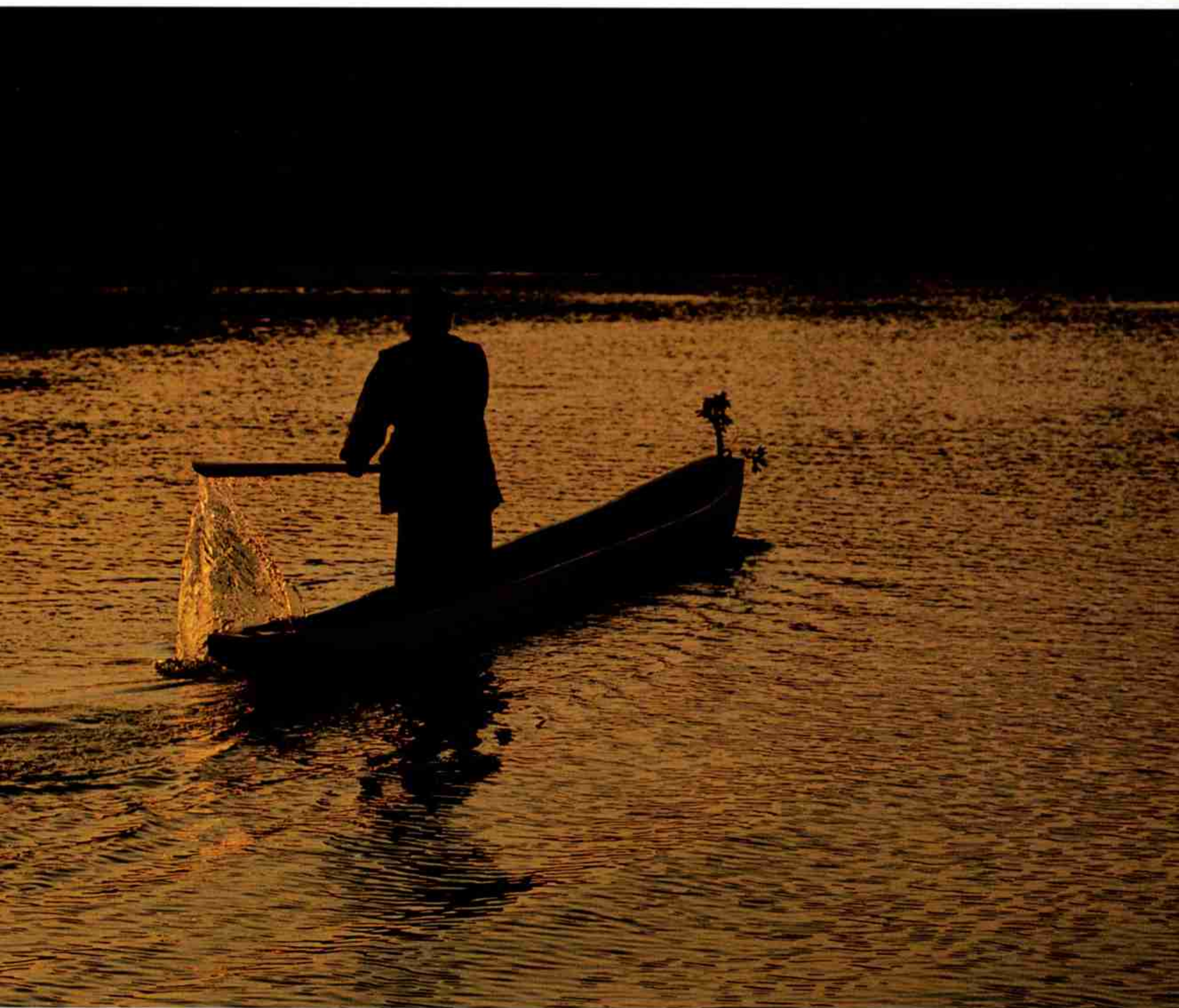
those animals had power. The people who came down here thought they could connect with the animals' power by painting them."

Everywhere I look I see painted horses, red deer, ibex, and especially bison. No two look the same. Each is drawn with meticulous detail. Many of the animals have spears stuck in them. But Clottes doubts they symbolize merely hunting. "The spears are rarely located at the most efficient places for killing animals," he explains. Instead, he thinks they might be spiritual spears—symbolic links between humans and the animals.

"We will never know the details of their ceremonies," says Clottes. "But with humans nothing is ever obvious. Who would think by looking at pictures of the Crucifixion in a cathedral that the essence of Christianity is love?"

WITHIN A MILLENNIUM OR two after they were painted in Niaux Cave, the great beasts were vanishing from the landscape of Europe. By 12,000 years ago warmer, wetter weather was beginning to take hold. The Ice Age was ebbing. Rising sea levels swamped coastal regions. Forests replaced grasslands and open woodlands across the continent. As their habitats disappeared, so did the bison and the mammoth.

But in some places large beasts persisted. The people who migrated across the Bering Strait discovered mammoths and mastodons. They found new spirit animals, including the bison that ranged in vast herds across the Great Plains. In Japan the Ainu people, direct descendants of the Ice Age Jomon culture, continued



to worship the bear into the 20th century. Few Ainu remain today, but among them are some who have kept the ancient beliefs alive. Shigeru Kayano, a 74-year-old man who grew up in a traditional Ainu home, has recorded 700 hours of recollections from elders. Over tea in his village of Nibutani, I ask about bears.

“The only thing stronger on Hokkaido than the Ainu,” he tells me, “was the bear. The bear brought gifts from the gods—his fur and his meat. The bear’s cubs were the gods’ children.”

Ainu villagers used to kill a female bear each spring, to send her spirit back to the gods. They would raise her cubs for several years and then return them to the gods as well.

Today the Ainu no longer kill bears. They exhibit them. At the Noboribetsu Bear Park dozens of brown bears prowl open-air concrete

pens as tourists stream by. Most of the bears sit and stare at the visitors like dogs waiting for a treat. Some rise up on their hind legs and clap their big paws until a tourist tosses a carrot. In a nearby building a bear in a muzzle draws applause by walking on his front paws and by tossing a basketball through a hoop.

These bears still bring gifts to humans—entertainment for the price of admission. But we have taken too much from them. As I watch a brown bear juggle several balls, I remember the Aborigine Alice Kelly telling me what I have lost. I see the half-human Löwenmensch striding through his Ice Age world, and I see the powerful beasts of Niaux Cave in flickering torchlight. I glance back at the juggling bear and wonder where our modern minds will lead us next. □

PLAYING THE SLOTS

By SCOTT THYBONY

Photographs by BILL HATCHER





Easing over the edge, a climber prepares to rappel down a 50-foot drop in Water Holes Canyon, one of the narrow slot canyons that score the land along the Arizona-Utah border. In this labyrinthine underworld a flash flood can be fatal, and a rope can be your best friend.

A DAWN BREEZE stirs the cottonwoods as I throw a Navajo blanket over my horse's back and heave on the saddle. Light strikes the canyon rim, igniting the treetops in a burst of spring green. With one night behind us in Forbidding Canyon we're ready to climb the mesa trail.

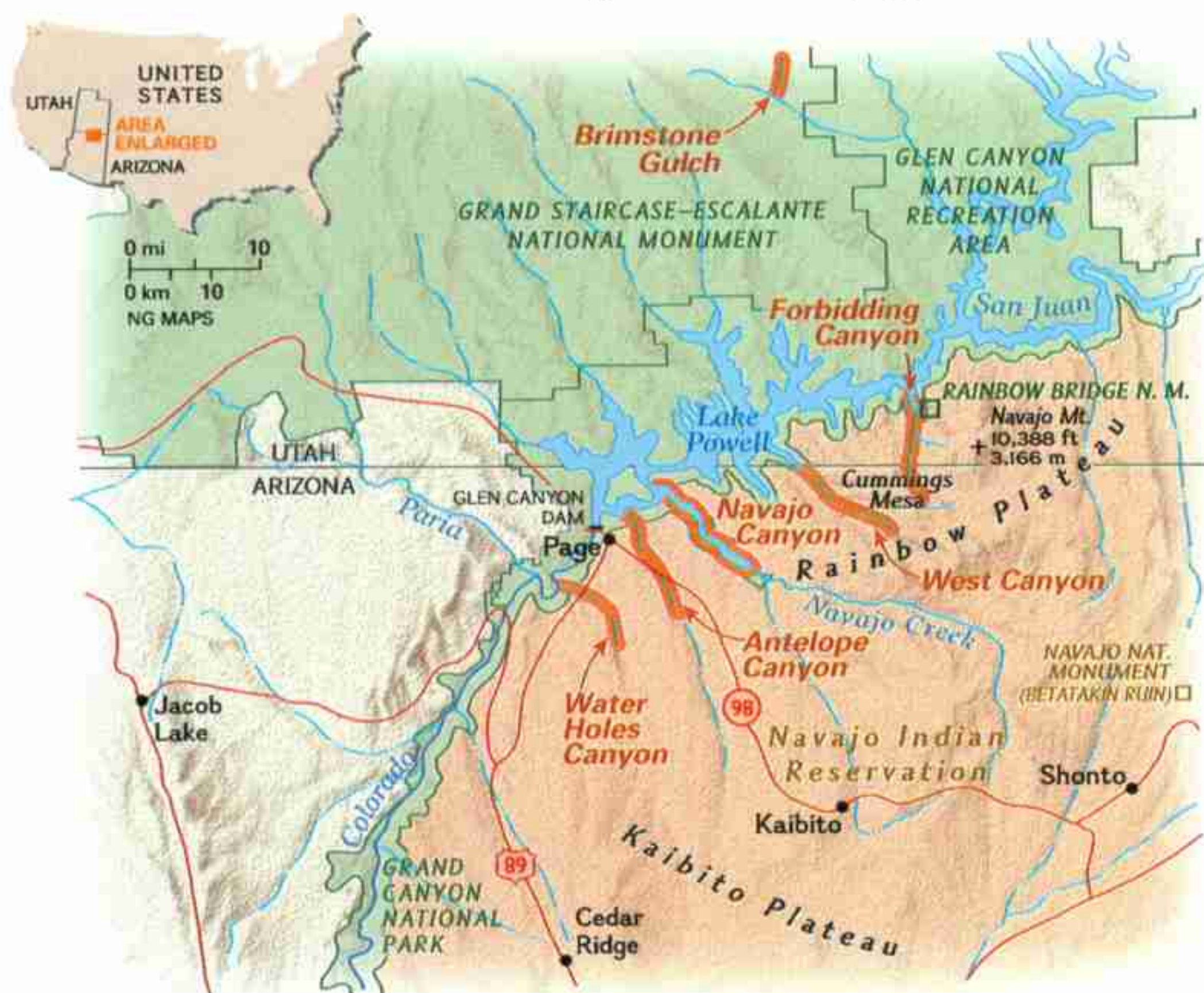
Our destination lies just beyond Cummings Mesa on Navajo lands along the border of Utah and Arizona. We're headed across remote and rugged Rainbow Plateau, a maze of sandstone knobs, forgotten Navajo trails, and treacherous gorges called slot canyons. The contours the slots carve in the rock are so fluid, so graceful, that it's easy to forget the violent forces that created them—raging floods that rise from nowhere with the sudden, heavy rainstorms that scour the plateau.

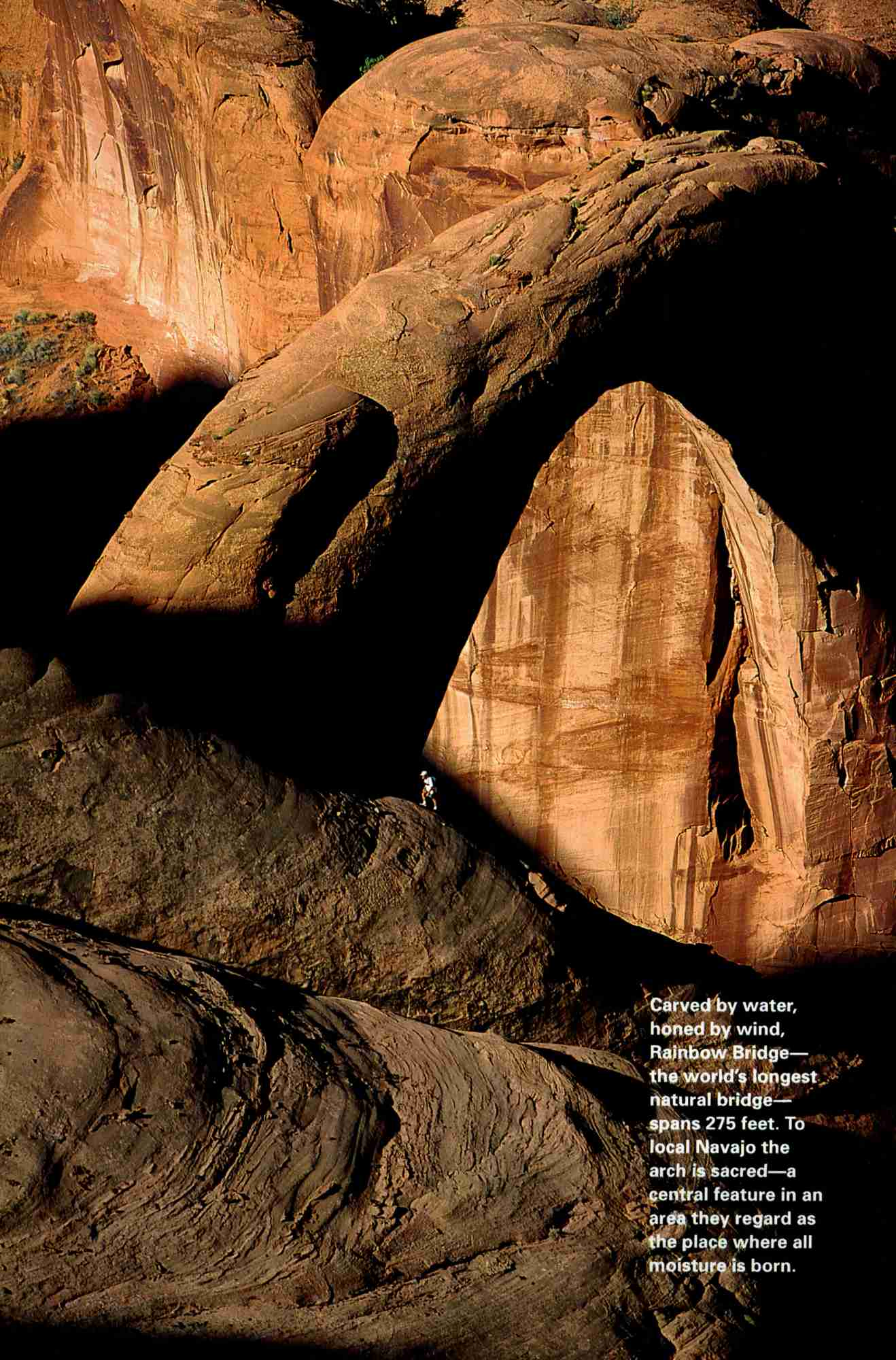
Few have ventured into the western canyons of the Rainbow Plateau, but for me this is not the first time. Twenty years ago I entered one of the finest of the slots—West Canyon, which slices through a remote western part of the plateau—during an overland trek from the south. On that trip I avoided the slot's tight upper narrows and ultimately was chased out of the lower canyon by a flash flood. But what I saw was enough to keep me dreaming of a return.

When Bill Hatcher, a photographer and a friend, mentioned his fascination with this country, we pulled out the maps. We would begin our exploration at the end of a sandy track below Navajo Mountain and cover the first ten miles to the top of Cummings Mesa on horseback, then continue on foot to a base camp near the east rim of West Canyon some four miles from the canyon head and about five from the southern edge of Lake Powell. From that point we would hike on high ground to the canyon head and then descend the winding narrows of the canyon's upper section, swimming through pools of early spring snowmelt and rappelling down a succession of steep drop-offs. After that we would take another day to traverse the lower narrows to the end of the canyon.

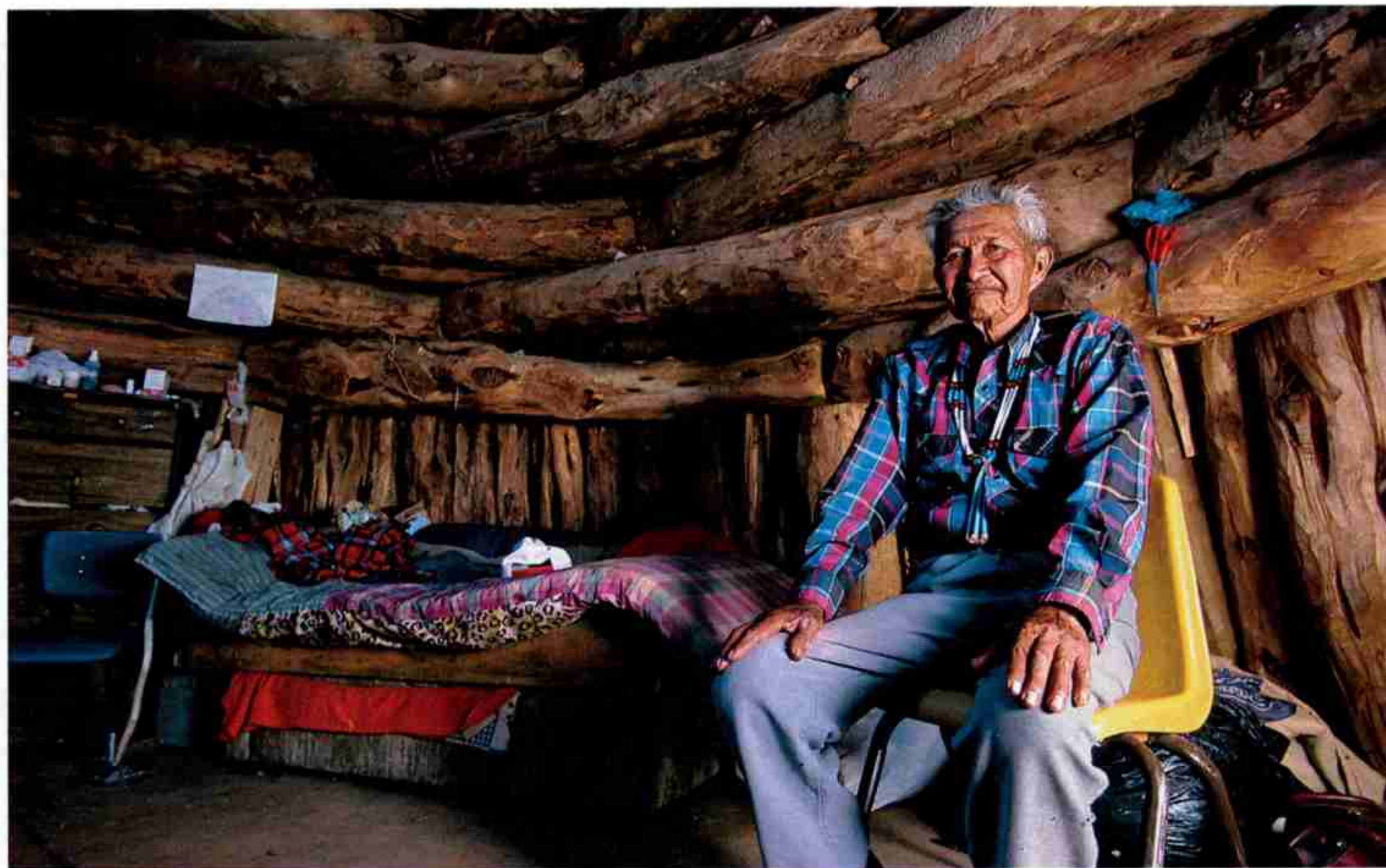
By full morning light the animals are saddled and packed, and we are

ready to start up the trail to the top of the mesa. With us are two Navajo guides, Jim Begishe and Leo Manheimer; a naturalist named John Manygoats; Tony Williams, a former park ranger and river guide; and Tyler Williams, a river guide with a passion for canyons. The pace quickens as horses and pack animals swing into line, threading their way between sand and layered sandstone. The air is hazy with dust kicked up by the wind. A line of tabular cliffs stretches along the western horizon; to the northeast stands Navajo Mountain, bulging dark as a





Carved by water,
honed by wind,
Rainbow Bridge—
the world's longest
natural bridge—
spans 275 feet. To
local Navajo the
arch is sacred—a
central feature in an
area they regard as
the place where all
moisture is born.



"These canyons kept me from being shipped off to Anglo boarding school," says Buck Navajo, a shepherd who lives in a traditional hogan. As a boy he hid out near Navajo Mountain to dodge Bureau of Indian Affairs truant round-ups. An old sheep trail leads hikers out of West Canyon (facing page), where prehistoric Anasazi images now serve as an exit sign.

rain cloud. Our trail meanders from mountain to mesa, where bare sandstone tosses in waves and sunken troughs, a sea of ancient dunes turned to rock. At the foot of Cummings Mesa we halt to tighten cinches and retie loads for the ascent.

The mesa trail angles back and forth, growing steeper; the horses pick their way up the talus and into the cliffs. We dismount and walk as the animals lunge up to precarious rock shelves. Hot breath from my horse's muzzle brushes my neck as I maneuver to keep in front.

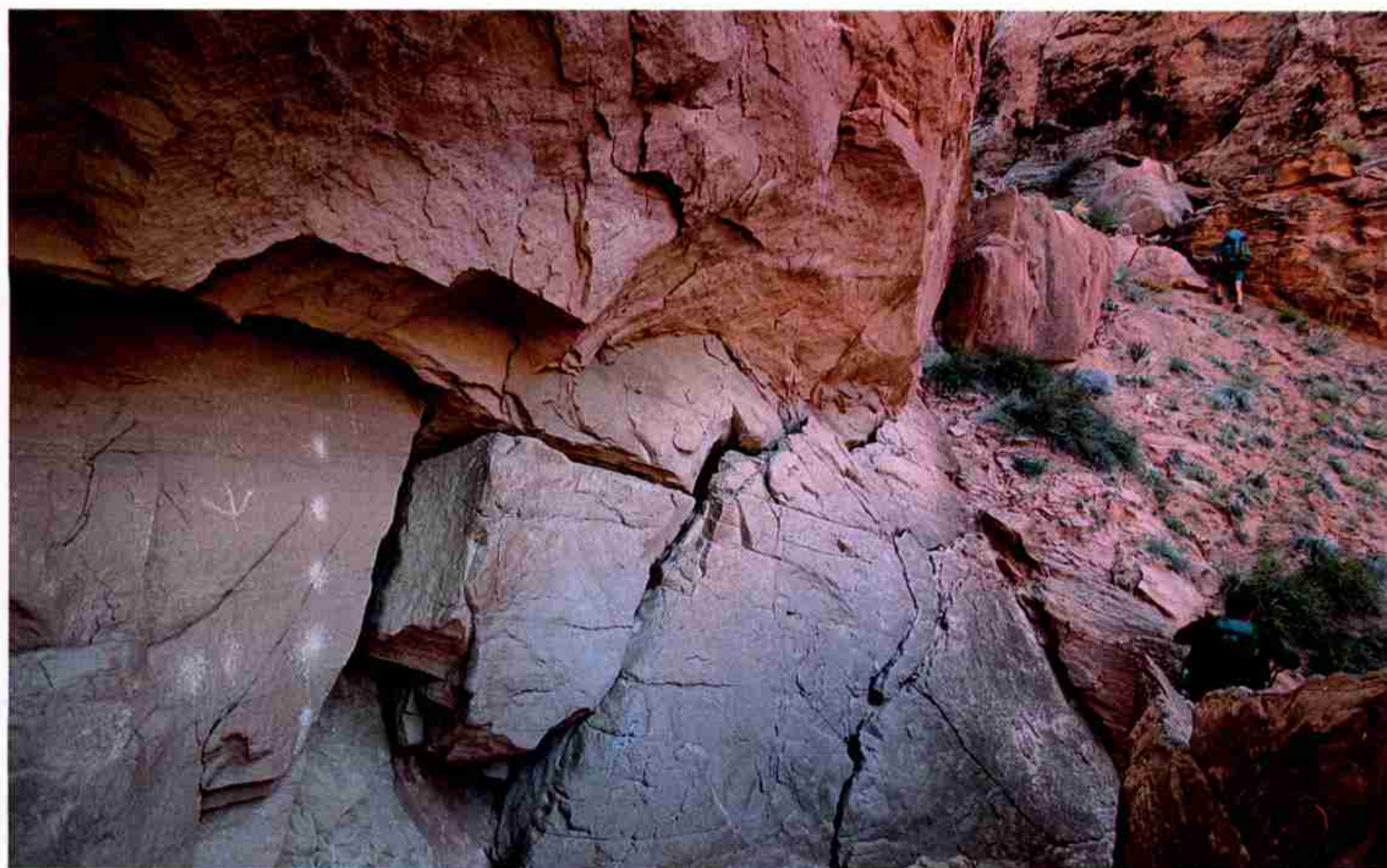
At a steep switchback where the trail squeezes between a boulder and the cliff face, the lead mule balks, bringing everything to a standstill. The loss of momentum sends a ripple of confusion through the string, and the horses stir uneasily, sidestepping, some trying to turn back while others crowd forward and bunch up at the turn. The Navajo guides begin to shout to each other.

A horse rears, backing toward the edge of a sheer drop. Its back legs slip over the edge. Tyler and Jim hang onto the reins with all their strength, leaning into the ground as the horse struggles to find a purchase. And then the horse is gone.

Tyler and John backtrack down the trail to retrieve the saddle from the horse, dead on the rocks below. With the loss hanging heavily over us, we spread out and continue to the mesa top. "What a day," sighs John. "What a day."

By noon we reach Jim Begishe's hogan, at one of the most isolated camps on the Navajo Reservation. This is where the trail ends and where we leave the horses and the two guides. We walk to the far edge of the mesa to look for the route—the vestige of a trail washed out years ago—that we'll use to shuttle loads of equipment and supplies to the base camp we will set up at West Canyon, 1,400 feet below.

SCOTT THYBONY'S work has appeared in National Geographic books and in *National Geographic Traveler*. BILL HATCHER photographed "Biking Across the Alaska Range" for the May 1997 issue of NATIONAL GEOGRAPHIC.



Before us stretches a rockscape flooded with light. Everything lies open, pared down to sky and stone. I try to trace the narrow canyon passage, but the rolling slickrock hides much of its course as it twists and falls and twists again for more than ten miles to Lake Powell.

During the 1920s Charles Bernheimer, a wealthy New Yorker, made half a dozen expeditions to this area. On his 1921 expedition he hoped to pioneer a western approach from Forbidding Canyon to Rainbow Bridge. In an account he wrote for *NATIONAL GEOGRAPHIC* in March 1923, he blamed his failure on “lack of food and feed, horseshoes, tools, and explosives.”

He returned in 1922 with a string of 28 animals, seven men, and a load of dynamite, TNT, and black powder. Rounding Navajo Mountain, Bernheimer reached Rainbow Bridge from the south—after six days of earthmoving.

Since dynamite exploration is no longer considered good form, we will make our way as modern canyoneers, traversing the canyon by climbing, rappelling, and swimming. Our gear, adapted from equipment used by rock climbers and cave explorers, includes dry suits, ropes, headlamps, and two-way radios.

UNDER A STRAIGHT-UP SUN that bleaches the sandstone to hues of pale ocher and ash gray, we shoulder our backpacks with the first load of supplies and equipment and descend to our base camp. By dusk, when we reach the camp with our last load of the day, the yellows and reds around us are so deep they seem to seep from the heart of the rock. Surrounded by a vast expanse of slickrock domes above a dark cleft leading into the main canyon, we shake out our sleeping bags and sleep.

After retrieving the last of our supplies the next morning, we scout the branches of West Canyon until we find the best entry into the upper section. It's so narrow the cleft disappears in swells of bare sandstone.



Ancient sand dunes turned to stone surround Navajo Mountain (above). Some five million years of rainwater and snow-melt cut canyons through the porous red rock. Viewed from above (facing page), a half-mile-long stretch of slot canyon—plunging 50 feet or more in some places—is intersected by a shorter slot.

Bernheimer does not mention this canyon in his diary, but he skirted it on “the most dreadful trail I have ever crossed.”

We fall asleep under a clear sky, but by dawn the weather has shifted. At breaking light, rain clouds are gathering to the south over country that drains toward the canyon. Sipping coffee, we weigh the risk of descending through the upper slot, about two hours from camp. We know the canyon contains abrupt drop-offs, but we don’t know how many or what other obstacles we might encounter: chockstones, as boulders wedged between the walls are called, tangles of driftwood, or plunge pools—deep basins carved by waterfalls.

The biggest mistake a canyoneer can make is to descend without the option of backtracking. In the fall of 1996 John Ey, a photographer from Tucson, entered a slot canyon north of here known as Brimstone Gulch. Certain he could find a way through, Ey lowered himself over an eight-foot cliff and let go. Hours later and totally exhausted, he found himself trapped in a rock chamber five feet long, three feet wide—and 60 feet tall. Dressed in shorts and a T-shirt, he had only five ounces of water and a few bites of a sandwich left. It was Tuesday, and no one expected him home until midnight Sunday.

“The nights were absolute terror,” Ey recounted. “The time went so slowly there’s almost no way to describe it.” He shivered so violently he could not fall asleep. Dozing off at last, he would wake with a start, praying it was morning. “Then I’d look at my watch, and only 10 or 15 minutes had passed.” He was so thirsty he forced himself to cry so he could lick the tears from his fingers.

Eight days after Ey entered the canyon, a search team using dogs reached the rim above him. They hauled him out with ropes—just in the nick of time. “That night,” Ey said, “it dropped into the 20s, and the next day it snowed.”

Ey was lucky. A group of hikers in Antelope Canyon, on the outskirts of Page, Arizona, on August 12, 1997, was not. A flash flood born of a



cloudburst over Kaibito Plateau, 15 miles away, sent so much water pounding through the tight gorge that it swirled 80 feet up the rock walls. The hikers, mostly young European tourists, had paused inside the canyon to pose for photographs. Francisco Quintana, their guide, heard the roar of the oncoming flood and wedged himself and two others into a cliff face. Moments later, the muddy torrent arrived and shot Quintana a quarter mile through the canyon in just seconds. When it was all over, he was the only survivor.

WATCHING THE STORM BREWING over Rainbow Plateau, we decide we have enough time to push ahead into the upper narrows if we split up for a quicker descent. Bill and Tyler will attempt to traverse the entire length of the upper canyon. Tony and I will accompany them part of the way, carrying ropes to support their effort, then climb out. John will remain on the rim with a radio, watching the weather.

On the canyon floor the four of us pull on our dry suits and climb down into the first pothole, a basin scoured into the bedrock by water-swirled sand and rock. Here at the bottom of the slot thick twilight lasts all day, and meltwater fills much of the sunken corridor. As we wade belly deep, the passage narrows and our view of the sky constricts to a vein of blue. Water deepens below the pour-offs. To swim the pools, we push waterproof packs in front of us for flotation. John's voice crackles over the radio. "Still the same," he says. "Clouds still forming."

Reaching a break in the east wall, where the canyon begins to close in even tighter, Tony and I hand off the ropes and climb out. Tyler and Bill are on their own now, passing into the deepest section, where radio contact is broken.

As we work our way along the rim above, Tyler and Bill enter a dark passageway. High walls press so close together at one point they have to take their packs off and twist sideways to fit through. They reach a log-jam that plugs the narrows and toss their packs over the tangle of debris, then tunnel underneath. For several hours the two carry on, rigging ropes at six separate drops. The last rappel lands them in a deep pool.

There are no escape routes in this section of the canyon, but farther down in the lower narrows a few Navajo sheep trails reach the canyon floor. Once Bill and Tyler complete the upper narrows, they find a sheep trail to the rim, where they join us as evening approaches. If the weather holds, we'll move camp into the canyon tomorrow and complete the descent through the lower narrows in one long day.

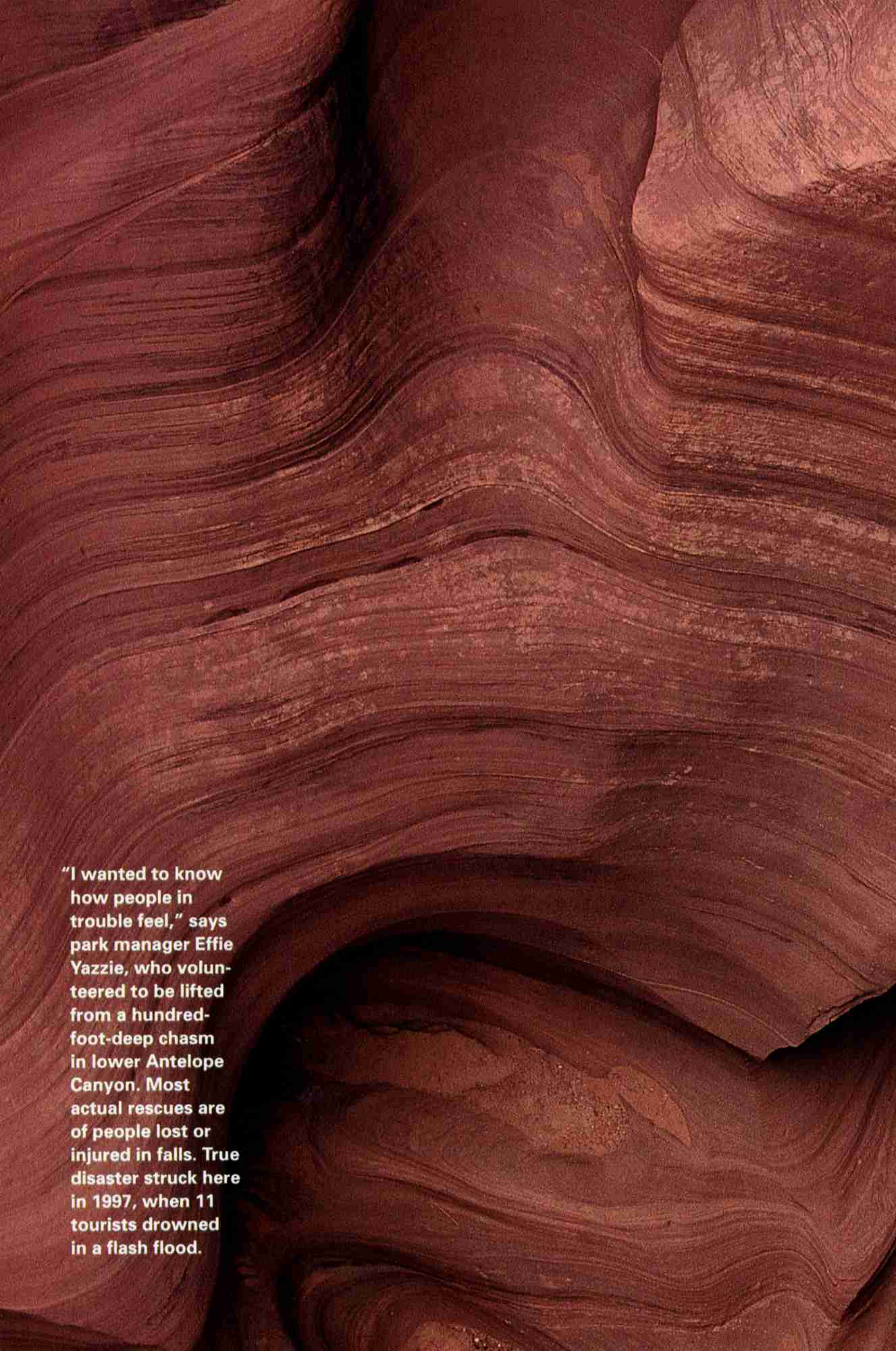
Rain falls in the evening, and clouds mass on the horizon the next morning, the beginning of the fifth day. We postpone our descent and head off to explore some of the surrounding country. By nightfall, as the storm arrives, we are camped at the rim of a distant slot canyon. Thunder rumbles, and a soft rain turns into a cold downpour.

In the dark before dawn I hear a sustained, high-pitched roar coming from the gorge, like a wind blowing steadily but never coming close. The canyon below us is flashing. The air hangs heavy with moisture, sharpening the scent of wet sand and juniper. A few hours later, at daybreak, I angle down the wet slickrock to watch the floodwaters pour over a cliff and cascade into a chain of bedrock basins. In a few hours only damp sand will remain.

Three days later we return to West Canyon to complete our descent. At our old camp our tracks have disappeared from the sand—a flood

With a spider's agility, canyoneers Eve Tallman, at top, and Glenn Rink inch their way down a 20-foot-high chute in a side slot of West Canyon. Such climbing is not for novices. Says Tallman: "Going up is only half the story."





"I wanted to know how people in trouble feel," says park manager Effie Yazzie, who volunteered to be lifted from a hundred-foot-deep chasm in lower Antelope Canyon. Most actual rescues are of people lost or injured in falls. True disaster struck here in 1997, when 11 tourists drowned in a flash flood.





“Sometimes you have to swim right into it,” says Eve Tallman, crossing a debris-choked pothole in Navajo Canyon. Rain leaves a shine on the cliffs (above) and washes leaves, branches, dirt, and even dead animals into canyon recesses. The muck stagnates until the next downpour flushes it out, and a new cycle begins in these back alleyways of canyon country.

has swept through. We move camp down to a wide pocket in the main canyon for an early start in the morning.

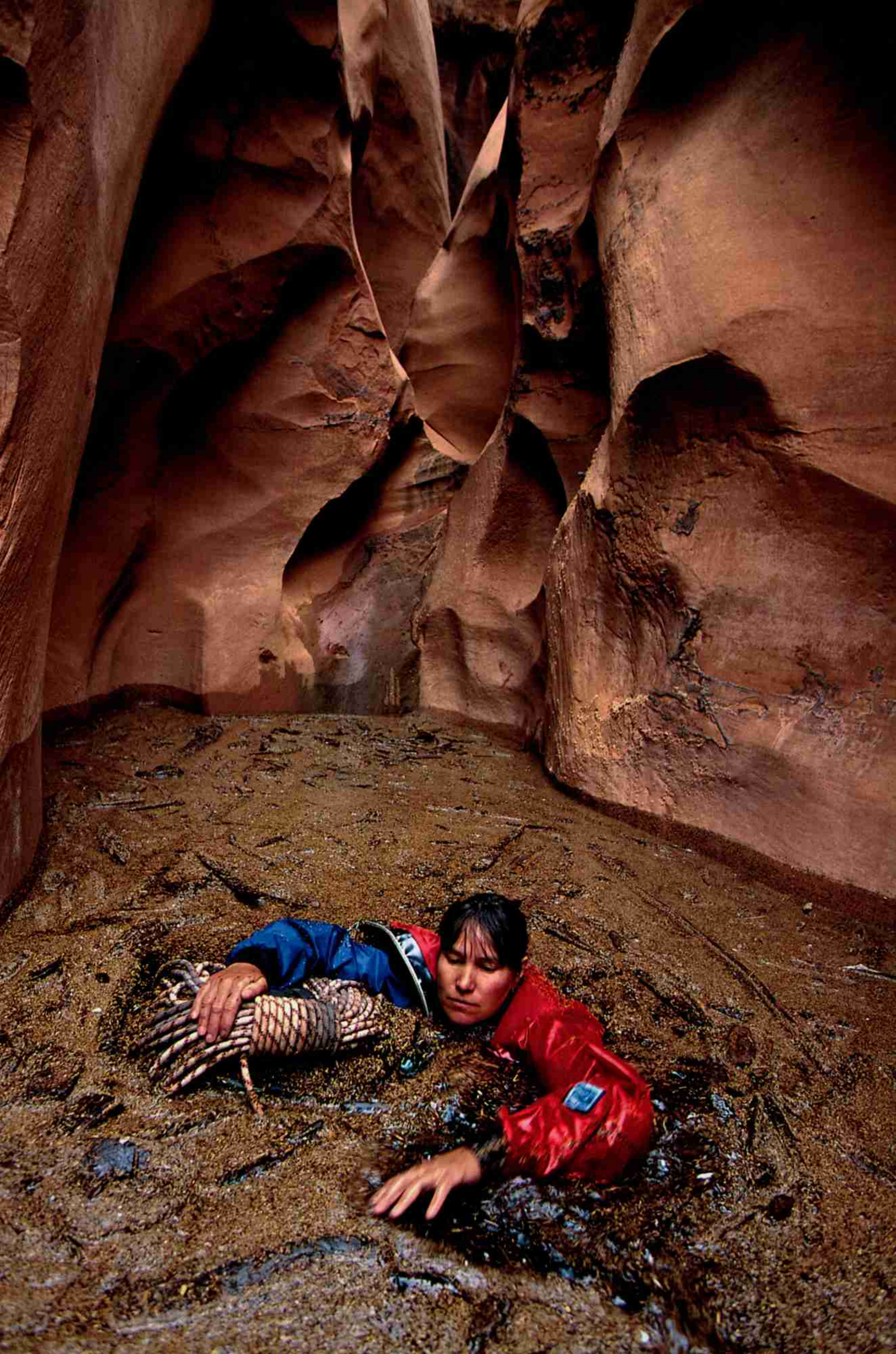
At dawn, clouds are rolling above the rim again. Bill and I decide to set out without the others. If all goes well, we will reach Lake Powell and return by dark. We’re racing the weather, glancing back at the sky as we push ahead. The stream channels through a narrowing passage, and the cliffs vault 400 feet overhead in endlessly curving faces. A recent flood churned through this gorge, leaving uprooted trees wedged across the narrows and driftwood jammed high above where we are now.

Bill, in the lead, steps into a deep patch of quicksand and sinks almost to his waist. Instinctively, he hands me his camera for a shot and then tries to extricate himself. He pulls out his right leg but can’t budge the left. I begin digging, but under a foot of flowing water the hole quickly fills back up. I scoop sand with both hands as Bill leans forward. Finally the suction breaks, and he’s free. “Maybe,” he says, “I should take up wedding photography.”

Five hours after leaving camp we exit the last narrows, a fluted channel augered through red bedrock. Pressed into the damp sand in front of us are fresh footprints and the tracks of a dog, most likely a boating party up from Lake Powell—the flooded core of Glen Canyon. We round several more bends and reach the lake’s high-water mark.

The threat of flooding makes it too dangerous to return the way we came. Bill spots a vertical crack leading to a break in the cliff above. Wedging into the crack, I press my back against one wall and my feet against the other and inch my way up. Bill leads the next climb up a set of ancient Indian hand- and footholds. We soon top the cliff and pause before starting back to join the others.

A slickrock expanse opens around us. Shadows from passing clouds race across the surface as the wind picks up and raindrops slap the ground. We begin our long journey across the Rainbow Plateau, keeping to a high route. In the canyon below, the water rises. □



FLASHBACK



KOLB BROTHERS

■ FROM THE GEOGRAPHIC ARCHIVES

Rock of Ages

This boulder wedged in a slot canyon along North Bass Trail was a Grand Canyon tourist attraction around 1905, when this photo was made, and remains one today. At that time photographers Ellsworth and Emery Kolb had a trailside darkroom below the South Rim to sell “instant” portraits of muleback visitors. Many of the chasm’s nooks were first explored and photographed by Ellsworth. When Emery showed their photos at the Society in 1913, “two hundred of our members who were unable to find seats, both at the afternoon and evening meetings, were content to stand through the entire lecture,” noted Editor Gilbert H. Grosvenor, who published this image in “Experiences in the Grand Canyon,” in August 1914.

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Behind the Scenes

The Damage Done

"I never saw anything like the loss and destruction I saw in Turkey after the earthquake," says GEOGRAPHIC illustrations editor Bert Fox (right, at left), "and I never saw people so brave in the face of such loss." He joined photographer Reza, at center, and writer Rick Gore, at right, for a week last summer to cover the disaster for this issue. Rick describes the collapse of this apartment building at Gölcük in his article.

Arriving near the epicenter three days after the earthquake occurred last August, the three men traced the damage along the North Anatolian Fault. They never got used to seeing such devastation—or smelling it. "Because of the risk of disease, we had to wear face masks all the time, but they could do only so much," says Bert. "The odor of death would still be on my clothes and skin when I got back to the hotel in Istanbul at night. You can't take a long-enough shower to wash off that smell," he adds. "I still have nightmares."



AYDIN KUDU



Stumped by Australian Logging

Environmental activist Kevin Briand, featured in this issue's article on Australia, spent two months on a tiny platform a hundred feet up a centuries-old karri tree to protect part of Western Australia's Lane Forest from clear-cutters. But when Kevin finally climbed down, the loggers moved in. He returned in December (left) to find what remained of the tree that had once been his home. Kevin isn't against all logging. He and other Australian tree sitters, he says, want to "stop the clear-felling and protect ancient forests."

RICHARD WOLDENDORP

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JOHN GIUSTINA

■ EXPLORERS-IN-RESIDENCE

This year the National Geographic Society expanded its Explorer-in-Residence Program to include representatives from seven different areas of scientific exploration. Beginning this month, Behind the Scenes will profile each program participant.

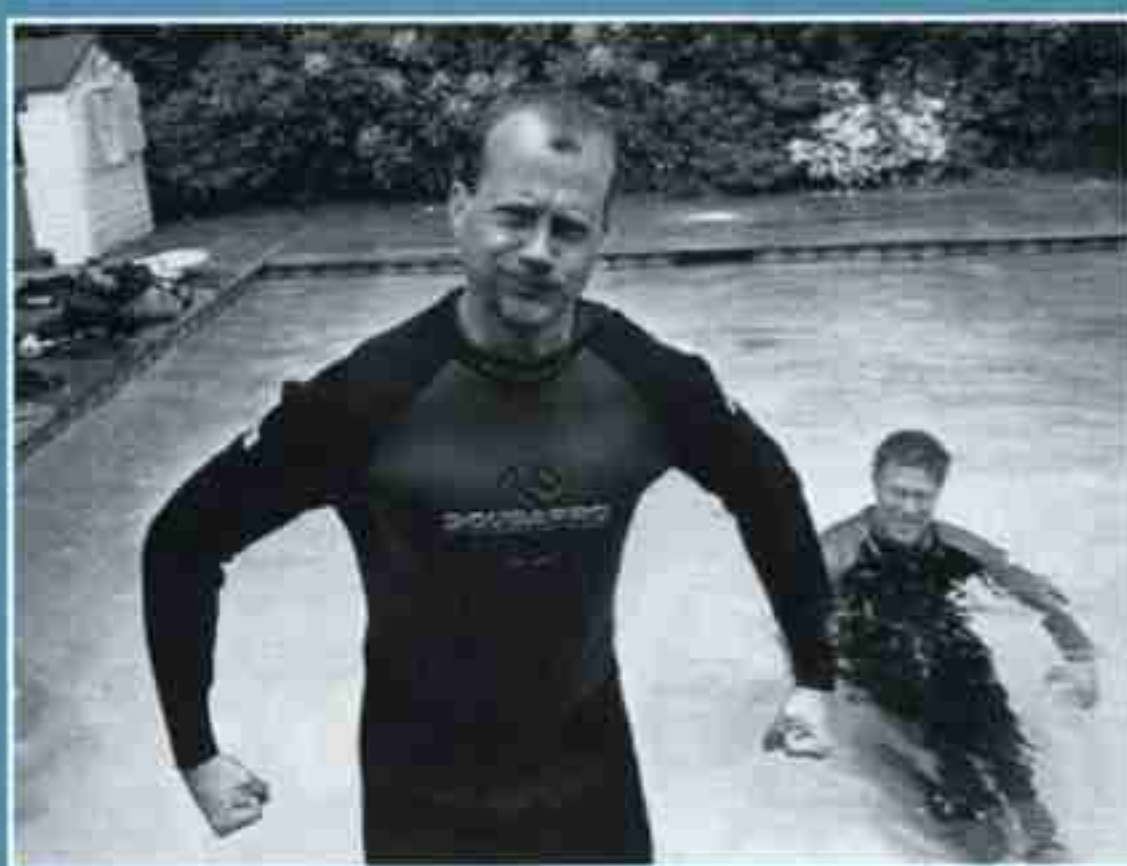
Jane Goodall: Primarily Primates

Forty years ago this month Jane Goodall arrived in the Gombe Stream Game Reserve (today Tanzania's Gombe National Park)—with her mother. Officials there wanted to be sure that the young woman studying wild

chimpanzees wouldn't be alone in the wilderness. Four months later the senior Goodall returned to England, but Jane stayed on, with National Geographic's sponsorship beginning in 1961. Her project, which she and mentor Louis Leakey felt would last ten years at most, has stretched across decades as the longest study of any animal species in its natural surroundings. Jane's role has also grown. Today she spends most of the year traveling to promote worldwide habitat conservation, a key element of her term as an explorer-in-residence.

Dr. Dive Puts Us in the Swim

When photographers like Randy Olson (right, at left) need scuba lessons for a Geographic assignment, they visit Virginia surgeon Ed Lane, at right. He's a certified diving teacher who got involved with the Geographic 15 years ago through diving enthusiast—and frequent contributor—Flip Nicklin. Now Ed's backyard pool is a scuba classroom and underwater camera testing site. He



DAVID GRIFFIN

even plans breaks from his medical practice to help out on our underwater stories, and he once saved a man's life while in the field with photographer David Doubilet.

TEXT BY MAGGIE ZACKOWITZ

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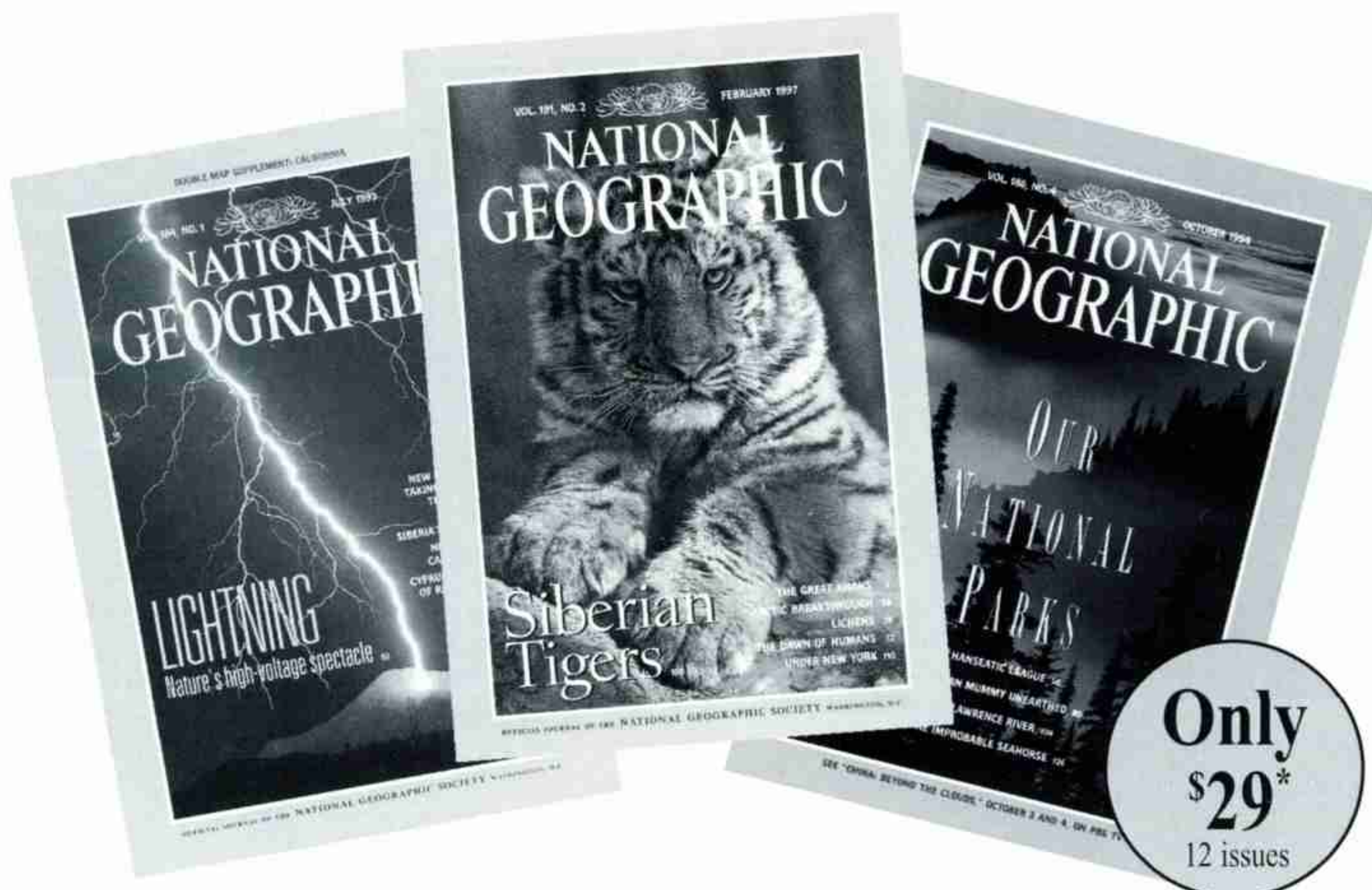
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NGALDW6

CartoGraphic

America's Patchwork of Colloquialisms

What is your name for a big oblong sandwich? If your answer is hoagie, you probably hail from Pennsylvania or New Jersey. If you call it a hero, odds are you're a New Yorker. If you say poor boy, you're most likely from Louisiana or another Gulf state.

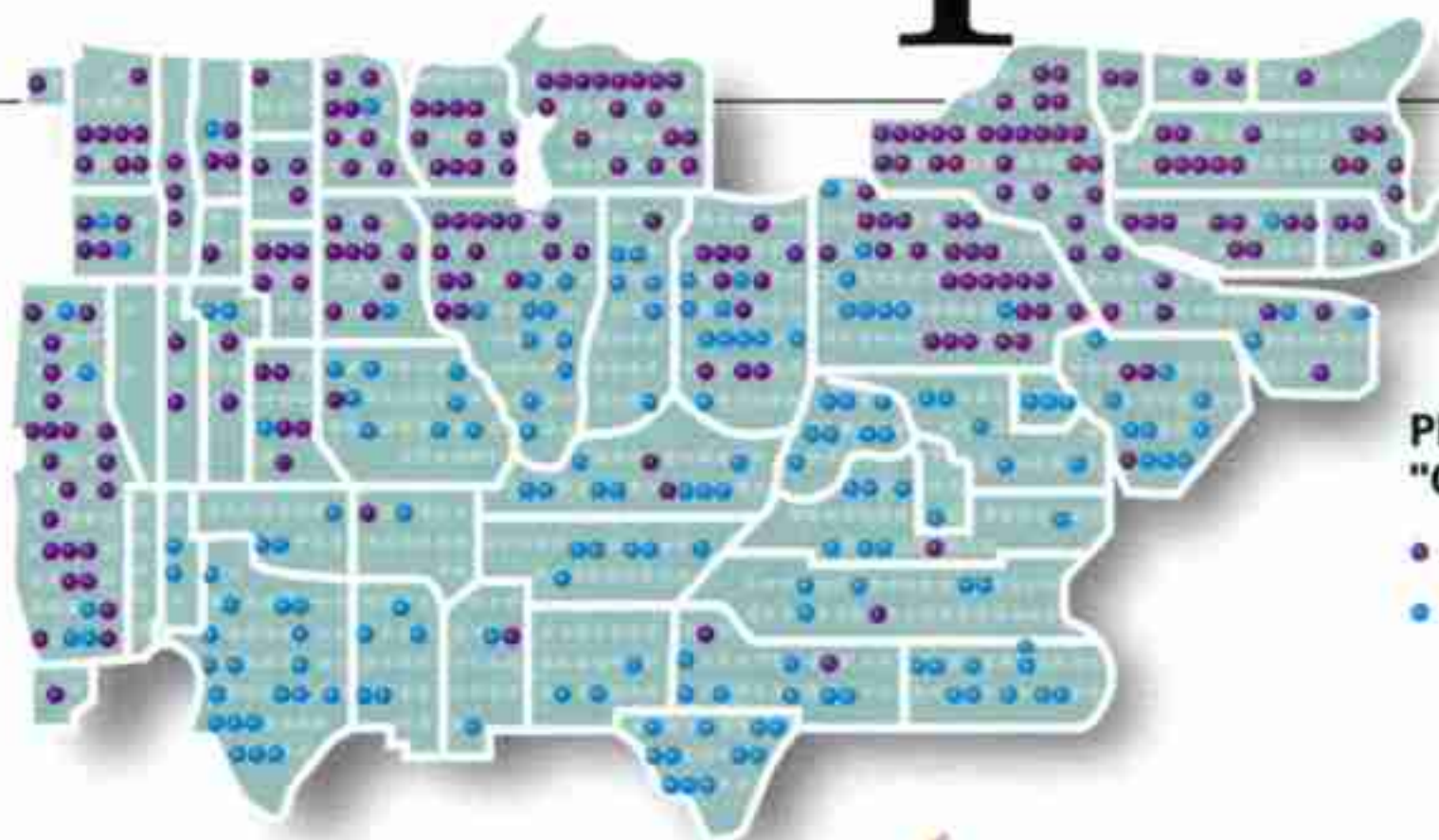
The maps at right, distorted to give states prominence relative to their population rather than their geographic area, reveal the United States as a multilayered patchwork of regional terms, the roots of which are deeply enmeshed in ethnicity, settlement patterns, and migration routes.

More than a thousand such maps pepper the pages of the *Dictionary of American Regional English*. *DARE* is a massive on-going enterprise that has yielded three thick volumes, with two more yet to be published.

Frederic G. Cassidy, the chief editor or high-muck-a-muck (according to his dictionary, variations include muckety-muck and monkey-monk), began planning the project in 1963. Reams of data are still being sifted from interviews conducted with 2,777 people from 1,002 communities nationwide between 1965 and 1970. Each dot on the maps represents a community.

Happily, regional variations persist despite our geographic mobility. *DARE* taps this resource by posting puzzling words on its website—<http://polyglot.lss.wisc.edu/dare/dare.html>—where people can report on usage in their home areas.

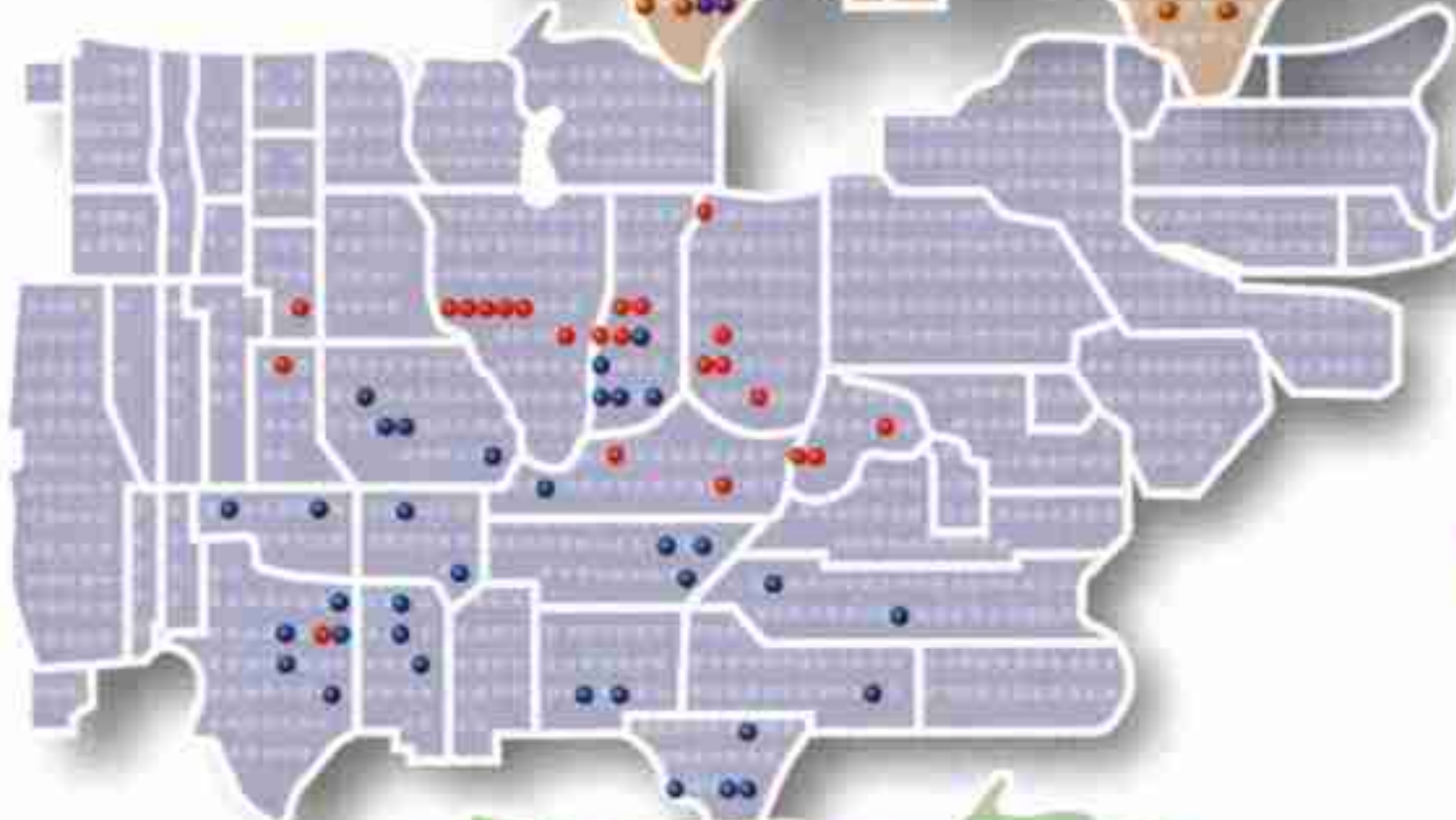
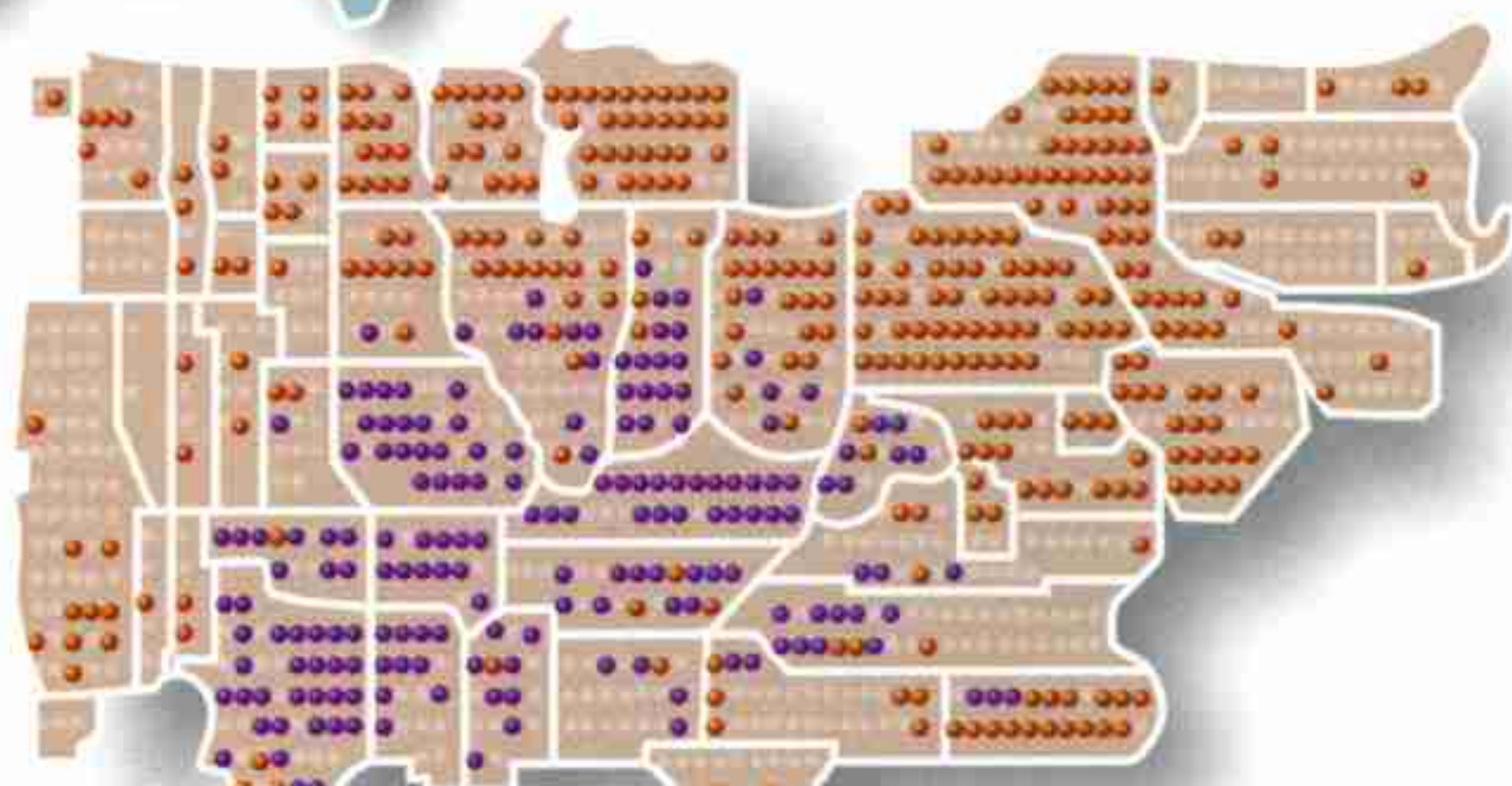
TEXT BY ALLEN CARROLL
Chief Cartographer



PRONUNCIATION OF "GREASY"

- Greecy
- Greazy

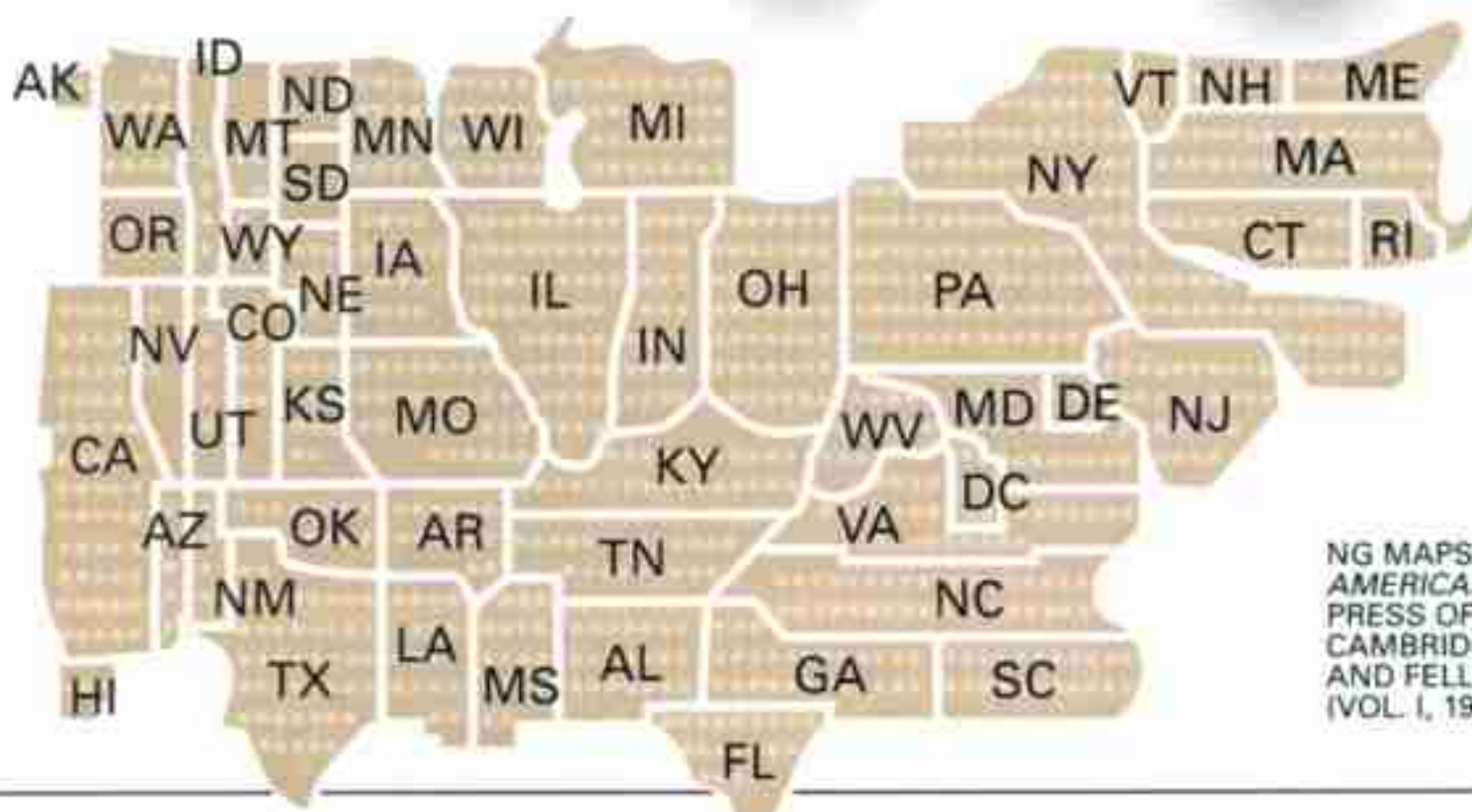
HARMONICA
Mouth organ •
French harp •



THUNDERSTORM

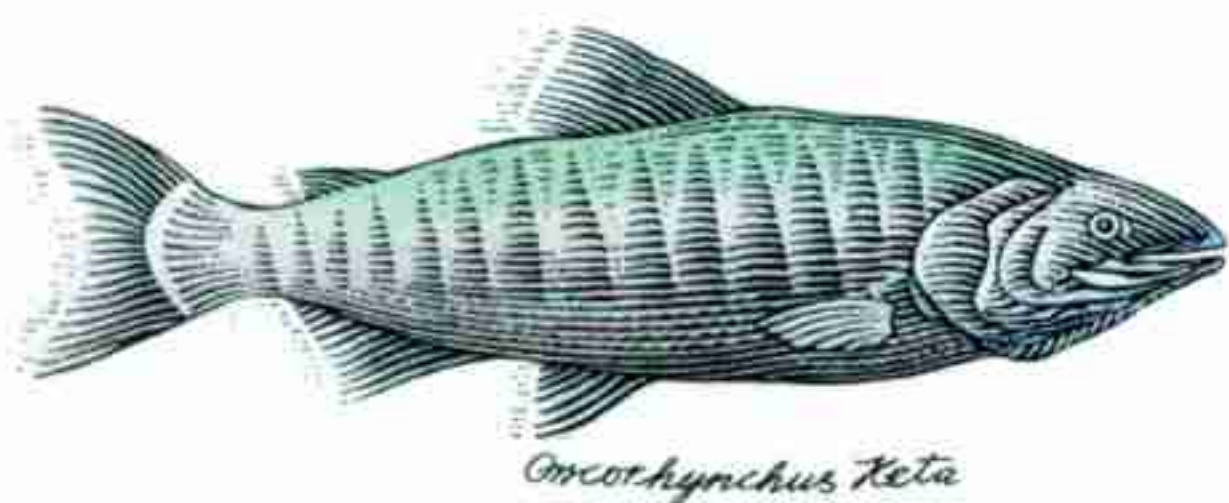
- Goose-drownder
- Toad-strangler

SANDLOT
BASEBALL
One old cat •
Cork ball •
Round-town •
Town ball •
Work-up •



NG MAPS: SOURCE: *DICTIONARY OF AMERICAN REGIONAL ENGLISH*, BELKNAP PRESS OF HARVARD UNIVERSITY PRESS, CAMBRIDGE, MASS. © THE PRESIDENT AND FELLOWS OF HARVARD COLLEGE (VOL. I, 1985; VOL. II, 1991; VOL. III, 1996)

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